Chapter 8

APPENDIX

Appendix 8-2-1 Equivalent distributed load to C-14 Loading

Bending moment of a simple beam due to C-14 is specified to compute using following equivalent distributed load.

	C-14 Loading				H-8 Loading	
L(m)	K=0	k=0.5	w(t/m)	Mmax(t*m)	w(t/m)	Mmax(t*m)
1.0	70	70	70	8.8	56	7.0
2.0	43.63	38.16	38.16	19.1	28	14.0
3.0	34.5	30.18	30.18	34.0	20.08	22.6
4.0	30.97	27.1	27.1	54.2	19.6	39.2
5.0	29.08	25.44	25.44	79.5	19.28	60.3
6.0	27.83	24.35	24.35	109.6	18.08	81.4
7.0	26.89	23.53	23.53	144.1	18.08	110.7
8.0	26.15	22.88	22.88	183.0	18.24	145.9
9.0	25.51	22.32	22.32	226.0	17.84	180.6
10.0	24.93	21.82	21.82	272.8	17.28	216.0
12.0	23.95	20.96	20.96	377.3	15.84	285.1
14.0	23.11	20.22	20.22	495.4	15.04	368.5
16.0	22.36	19.56	19.56	625.9	14.56	465.9
18.0	21.69	18.97	18.97	768.3	14.32	580.0
20.0	21.07	18.44	18.44	922.0	13.92	696.0

Note

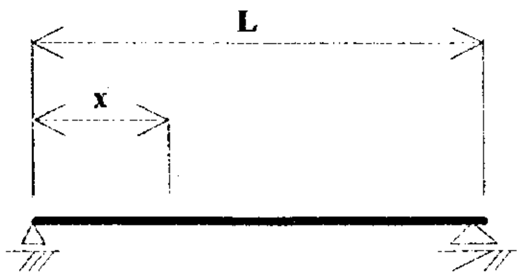
L: Clear span length of a simple beam.

w: Equivalent uniform distributed load for computation of max. bending moment of a simple beam.

Mx: Bending Moment at a distance of "x" from a support.

k: Equivalent distributed load to compute bending moment of a simple beam.

$$Mx = k*x*(L-x)/2$$



APPENDIX 8-2-2

Bridge Reconstruction to Power Plant No. 3

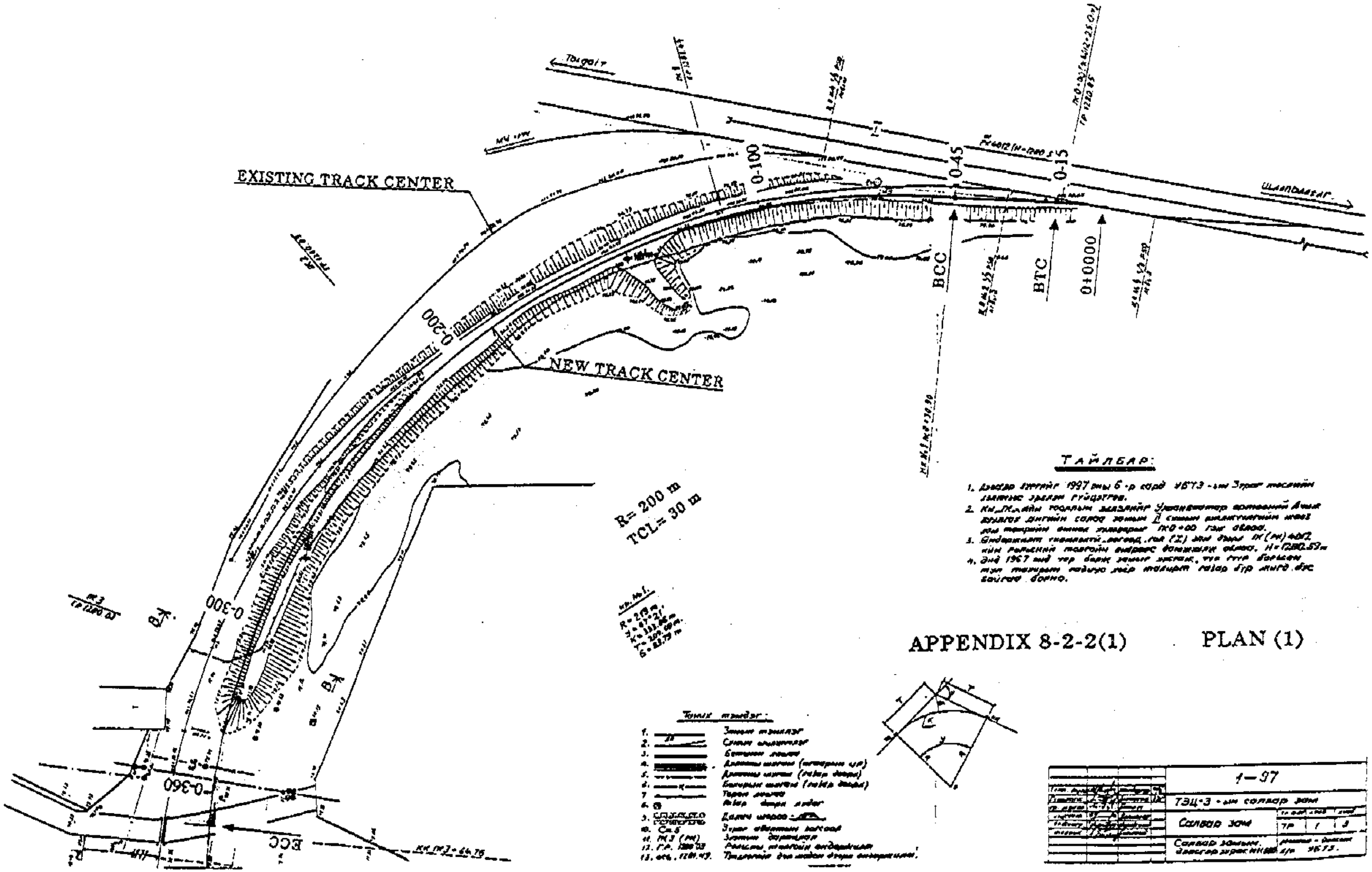
Present Condition

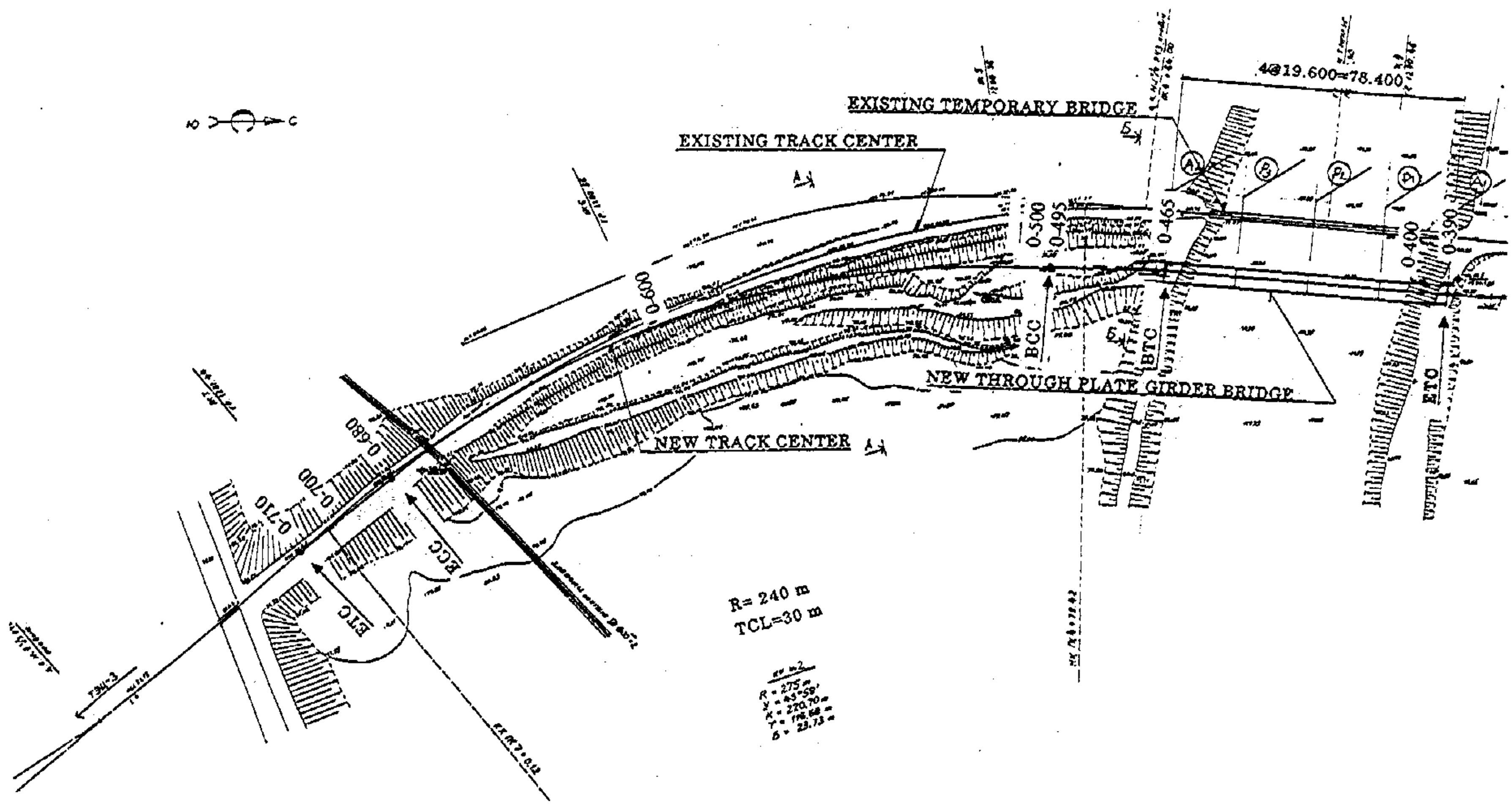
The bridge is a temporary structure constructed after the original bridge structures had been washed away, which is solely connecting the power plant with the main line track transporting coals for power generation as a life line of the people living in the Uraan-baatar.
The present status of the temporary bridge is shown in Fig. 8-2-2-(4). Superstructure is composed of various assorted steel bridge type structures. Substructure consists of timber cribs with steel sheet piles enclosing that. All of these are only temporary structure built years ago and the condition is rather poor now.
The substructure is sinking due to wheel loads during trains passing on the bridge. It might be going beyond suitable repair/rehabilitation life period of the structure within some years which may induce lack of fuel to generate electricity or short of electricity in Uraan-baatar.

Reconstruction Plan

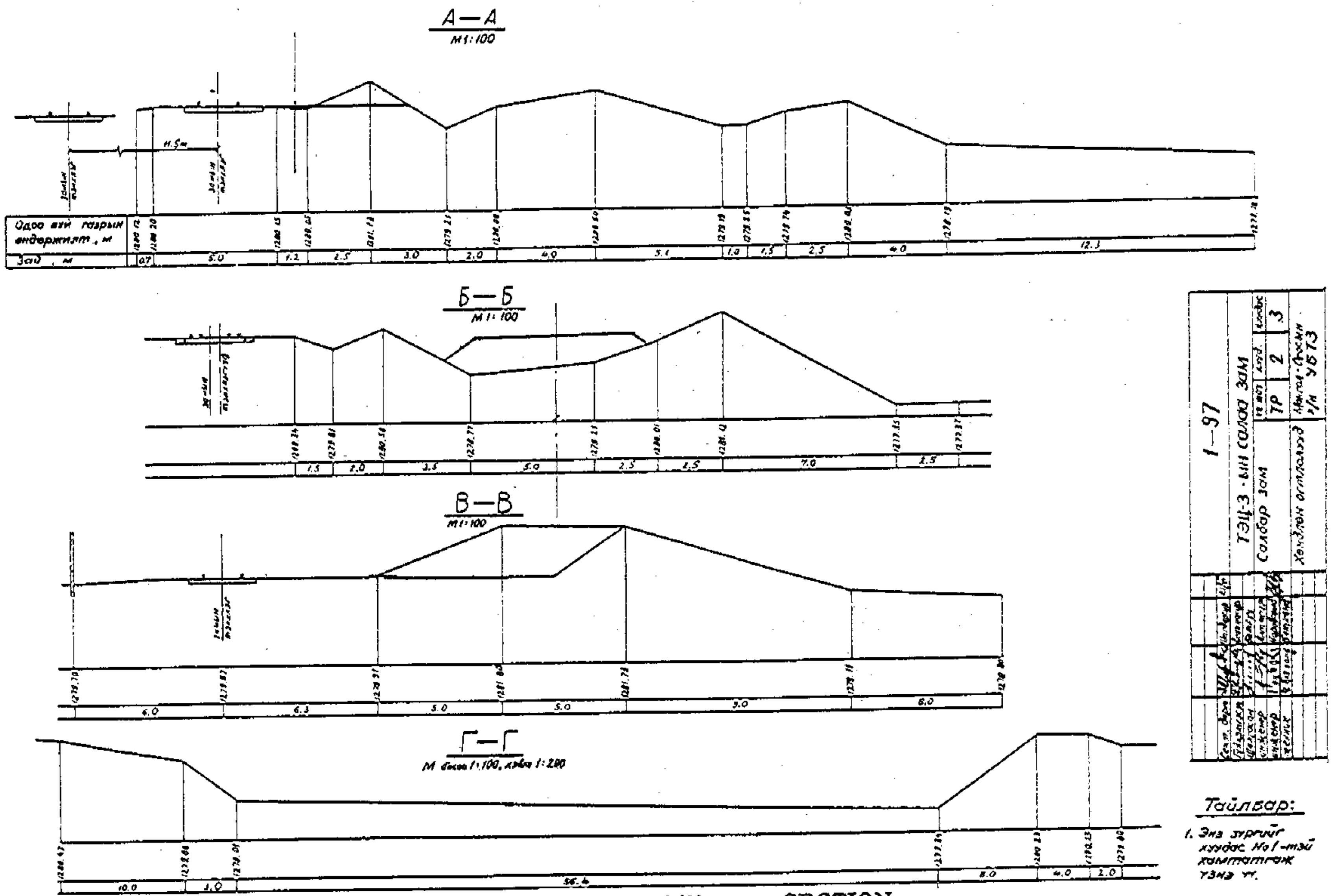
The alignment branching from the main line track to the power plant is planned to connect with the existing line before the existing overhead steam pipes.
The bridge is planned as four span bridge of Steel Through Plate Girder Type with a total bridge length of 78.4 meter. The substructure and foundation is planned as cast-in-place concrete structure with spread footing foundation type.
The reconstruction plan and its approximate construction cost is illustrated in attached figures/table.
Approximate construction cost including appurtenant work such as raising up of approach road and others is US$ 1.3 million.

APPENDIX 8-2-2(1) PLAN (1)

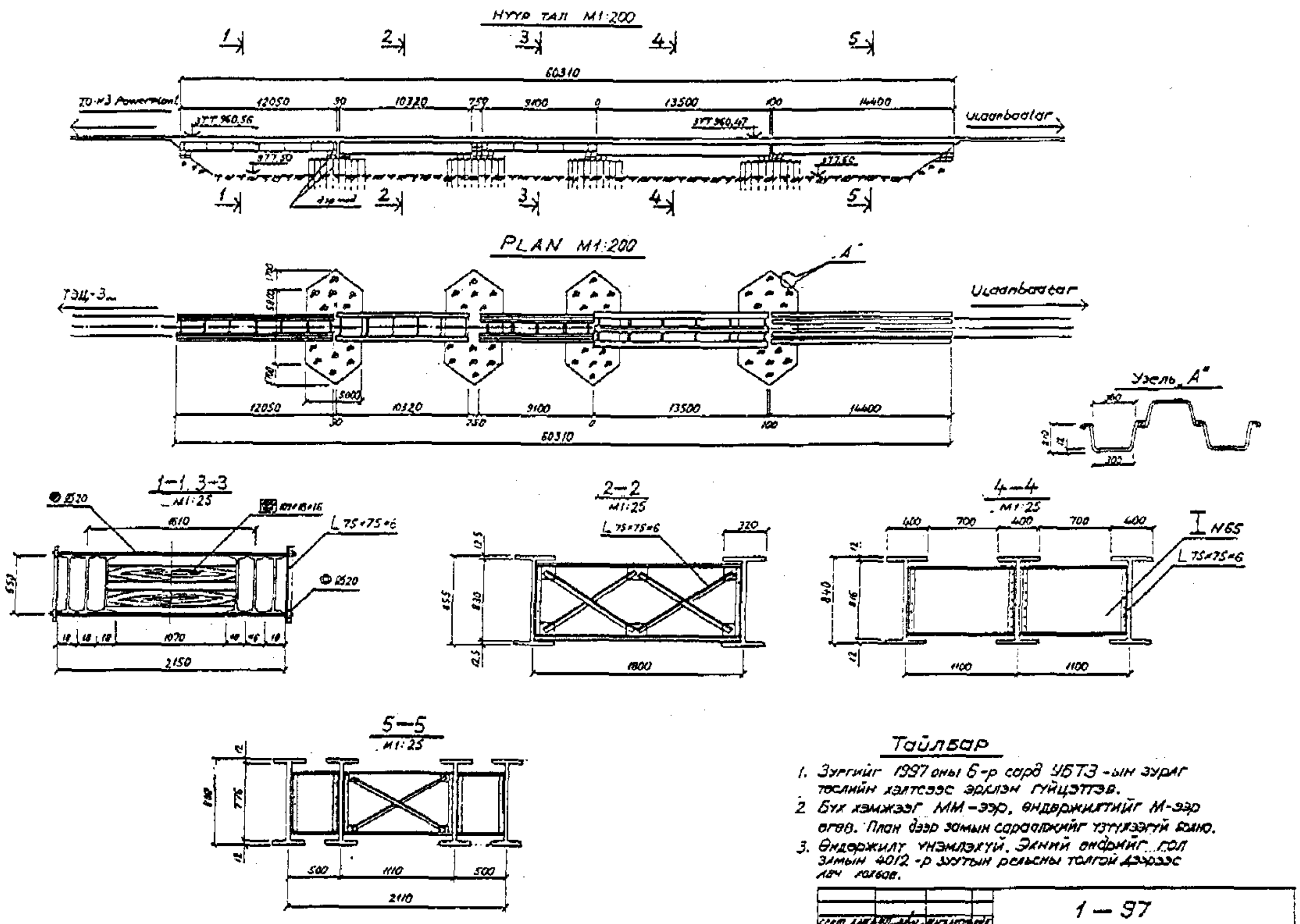


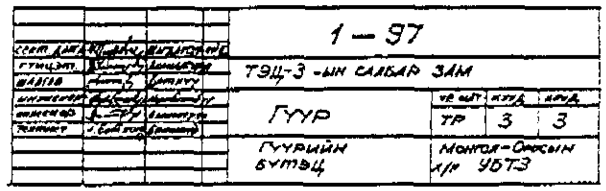


APPENDIX 8-2-2(2) PLAN (2)

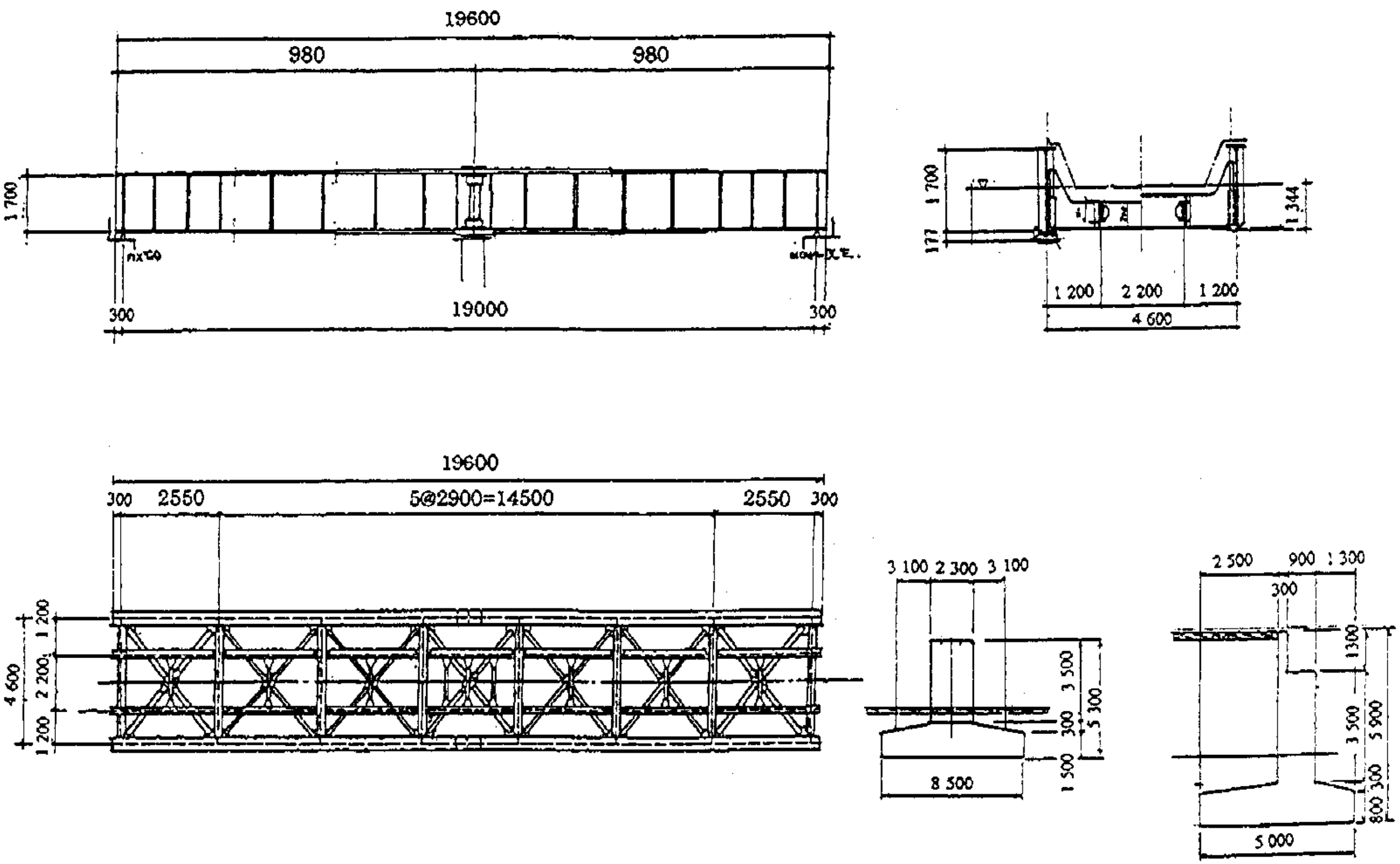


APPENDIX 8-2-2(3) SECTION

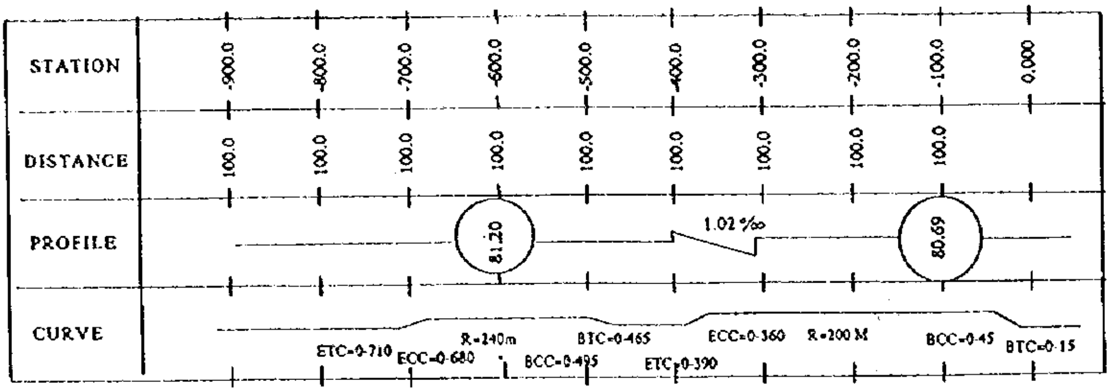




APPENDIX 8-2-2(4) EXISTING TEMPORARY BRIDGE



APPENDIX 8-2-2(5) NEW THROUGH PLATE GIRDER BRIDGE



APPENDIX 8-2-2(6) PROFILE

Approximate Quantity and Cost US$

Description	Type, Class	Unit	Qty.	Unit Cost Local	Unit Cost Foreign	Amount Local	Amount Foreign
Structure Steel	Superstructure	ton	158.01	0.00	5454.55	0	861,891
Concrete	Substructure	cu.m	529.55	1.61	192.76	854	102,078
Structure Excavation		cu.m	1036.97	1.78	4.54	1,848	4,704
Embankment		cu.m	2106.25	0.00	18.57	2	39,119
Common Excavation		cu.m	1200.00	0.00	5.55	0	6,665
Track Work		m	660.00	0.53	204.09	347	134,700
Grouted rip rpa		cu.m		0.33	19.15	0	0
Demolition		LS	1.00			153	57,458
Miscellaneous	10 percent	LS	1.00			305	114,916
Total						3,508	1,321,531

TAB. APPROXIMATE CONSTRUCTION COST (DIRECT COST)

Appendix 8-2-3 Specification of Japanese bridge over a river

(1) Substructure interval

Q : Planning high water volume of the river (m3/sec)

L : Interval of substructures (m)

Q < 500m3	River width < 30m	L > 12.5 m	
	River width > 30m	L > 15.0 m	
500m3 < Q <2000m3		L > 20.0 m	
2000m3 < Q		L > 20+0.005Q	
Maximum interval	at main stream		70m
	outside of main stream		30m

(2) Construction level of footing

The upper level of the footing must be constructed 1 m or more below than the river bed at flood channel and 2 m or more below than the river bed at common channel.

But if there is no fear to scour the river bed it may construct otherwise.

App. 8-2-4

Railway Location between Honkhor and Bayan by a Contour Plan (S=1/50,000)

(1) Introduction

This study is to examine roughly the technical possibility of rough selection of Railway Route between Honkhor and Bayan by using existing topographical and geographical maps at a scale of 1/50,000, at the request of the Mongolian Railway.

The natural ground of this section has a rise of 16 ‰, for which it was constructed to establish a railway rout extension with the curvature of R=300 m radius using a series of small curves which resulted in an overall true grade of about 9 ‰.

The related problems will be as follows:

1) Increase in the overall track length ··· The straight-line distance between Honkhor and Bayan Stations is approximately 13 km, and the existing railway rout is about 19 km, which means that the track length is about 6 km longer.

2) A large difference in the running speed between the up- and down-freight train ···The running speed of the up freight trains hauling the full tractive capacity is determined by the up - grade 9 ‰, and the equilibrium running speed is approximately 20 km/h; while the down-freight train speed is restricted by the curvature of R= 300m and the running speed is approximately 80 km/ h, and the difference in the running speeds are very large.

3) Large rail wear in the curves ···There are excessive wear in the outside rail at curves of R =300 m. The reason for this hard wear is due to the fact that the Mongolian Railway have a rule to establish the rail cant for the average train speeds, and the true cant is 130 mm, where the maximum cant is 150 mm. The cant deficiency against the maximum running speed is large (140 mm calculated), and this could be one reason which contributes greatly to the rail wear.

As a countermeasure the guiding surface of the outer rail on curves are lubricated, and the head- hardened rails are being introduced afresh. Other measures being taken is to reduce the deficiency of cant, and to limit the maximum speeds on the down-grades, or to increase the train speeds when negotiating the up-grades.

Drastic improvement of the track alignment in the above section is to change the radius of curvature to be larger than 600 m. So the desirable thing to do is to select the railway rout for these condition, and to construct the new railway to meet these standards.

In order to meet these condition, it is recommended to select the railway location for a start, and the standards of the design for the new line should be as follows:

- Maximum grade ········ 9 ‰
  curve compensation when R≧600 m, i= 0.5
- Minimum radius of curvature ········600 m
- Transition curve length ········ l = 90 m (0.6 times max. allowable cant)

(2) Study to be made in Railway Location (Fig. 1 and 2)

1) Selection of Route between Honkhor ~ Bayan (Ref. Fig. 1 ①, ②)

· Scheme 1. ···· From the existing line exiting Honkhor Station select along the existing line and connect back to the existing line for the shortest distance possible.

· Scheme 2. ···· From the track exiting Honkhor Station, find a route along the branch line to Nalaikh, and connect to the existing railway line.

2) Selecting a railway route between the entry and exit point of Honkhor Station (Refer to Fig. 1 ③)

In order to remove the S-curves of 300 m radius at the route entrance of Honkhor Station, select a route from the vicinity of Km 425 + 500 to the exit of Honkhor Station (near Km 430 + 500), and to redesign of the station layout.

(3) Railway Location between Honkhor to Bayan

Scheme 2 is preferable for this plan, it is not possible to lower the Rail Level of the existing line exiting the Honkhor Station. For this reason, it is necessary to make future studies of Scheme 1 (Table 1).

(4) Selection of Railway Routs between the entrance and exit at Honkhor Station and study for Station Layout

1) Requirement for the establishment of a station

Honkhor Station is required to be near the existing station to maintain station interval and the track capacity on the main line, etc. without the function as the junction. And this station will be the important one as the junction to the brunch line if the equipment is constructed at Nalaikh in future.

Table 1 Comparisons of Scheme 1 and 2

Item	Scheme 1	Scheme 2
1 Route Layout	Runs parallel to the existing line	Runs parallel to existing Nalaikh Branch Line
2 Connection with existing line	Connects to existing route near Km 444+500 (New Line Km 439+500). Shortest route of new route.	The difference in the rail level near Km 444+500 on the existing route is 12 m, and is barely able to connect with the existing rail level at Bayan Station.
3 Crossing of steppe	Crosses steppe twice, and will damage the environment.	Crosses steppe once, affect to environment less than Scheme 1,
4 Cuts (relation to the Permafrost).	Many cuts near Km 432 + 500 on existing route, some 20m deep. High possibility of cut in Permafrost.	Cut one-way slope of hills, little possibility of cut into Permafrost.
5 Crossing the swamps	Cut through swamp will be required near Km 433 on existing line.	None.
6 Other related issues.		Relocation of existing route of approx. 1 km near exit Honkhor Station required due to obstructions.
Conclusion	Not recommended due to high construction costs, and affects to environment extremely.	Recommended, affects to environment least, low construction cost.
Special Matters	· Rail level at exit point of Bayan Station is easy to connect even when rail level is lowered 10m at exit of rail level from Honkhor Station, and this route needs to be checked for its merits. So Schema 1 need to be investigated and study.	· Rail level at exit of Honkhor Station can not be set at lower level than existing elevation of the Rail Level. · Rail level is lower than river level at some river crossings, and needs raising the track from present rail level.

2) Route Selection

① The Plan to connect the entry point near Km 425 + 500 and Km 430 +500 (Km 429 +

500 on the new route) of Honkhor Station with a straight line will require lowering of the elevation at the exit point from its present elevation by about 10 m, which will be lower than the level of the rivers on both sides of the Station, and it will be almost impossible to relocate the Station from its present location. Hence, this plan will not be considered further in this study.

② In order to not lower the rail level, if a route with a minimum curve of 600 m radius is selected along the existing route, it will be impossible to connect with the exit point of Honkhor Station. It will not be possible to design a low slope which is necessary to the main line for the Station.

③ For this reason, it will not be possible to reduce the grade of the main line to be less than 9 ‰, and so the Honkhor Station will become a Switch- back Station.

However, as a result of adopting the station layout and operate trains as described in Clause ④, the drawback of the switch-back layout in the said station can be improved by the following feature which will reduce the problems caused by the new track layout:

④ Train operations at the New Honkhor Station

The track layout at the New Honkhor Station will become as shown in Fig. 3, and the refuge trains on the Main Line bound for Bayan which are entered the Station will be only the freight trains and they will enter the refuge tracks for forward and backward operation. In order to avoid this forward and backward operation, the trains bound for Ulaan-baatar will be mainly entered the refuge tracks at the new station., The trains bound for Bayan will be operated as through trains, and overtaken at other stations , not at the New Honkhor Station. And this will reduce the effects of the switch-back operation.

[Use of tracks at the New Honkhor Station]

(a) Major Points of the Track Layout ··· The track layout at the New Honkhor Station on the Ulaan-baatar side will be as shown in Fig. 3 'A', and have the connecting route of a 14 ‰ grade.

(b) The Tracks for the Train Operation

a) Passenger Train ···Use the Main Track in principle, but the refuge trains will use the newly connecting rout 'A'.

b) Freight Train on the Main Line

i) Through Trains ···Use Main Track

ii) Refuge Trains bound for Ulaan-baatar ···Enter the Refuge Track No. 1 or No. 2

directly, and depart through the connecting route 'A'.

iii) Refuge trains bound for Bayan ···Enter Branch Line 'B' once, re-enter Refuge Track No. 1 or No. 2, and depart directly for Bayan.

c) Freight Trains in Branch Line

Depending on the connecting route, trains will enter and depart from Track No. 1 or No. 2 directly. The reason for this is that the coal train to Nalaikh will be loaded when heading for Ulaan-baatar and return empty when headed back to Nalaikh, and the connecting route on the lines will present no problems.

⑤ Grades on the Branch Line.

There are two schools of thought concerning this issue; one that the quality of coal from Nalaikh is of high grade and that there will be more development in the shipment of coal, and the other opinion that coal is running out at its source, and that the abandoned coal mines will be used for some other facility. It will take some time before any conclusion can be made. But there are some grades on the route bound for Nalaikh having a rise of 14‰, and in any case if no improvements are performed, trains can still be operated on the connecting route without any problem.

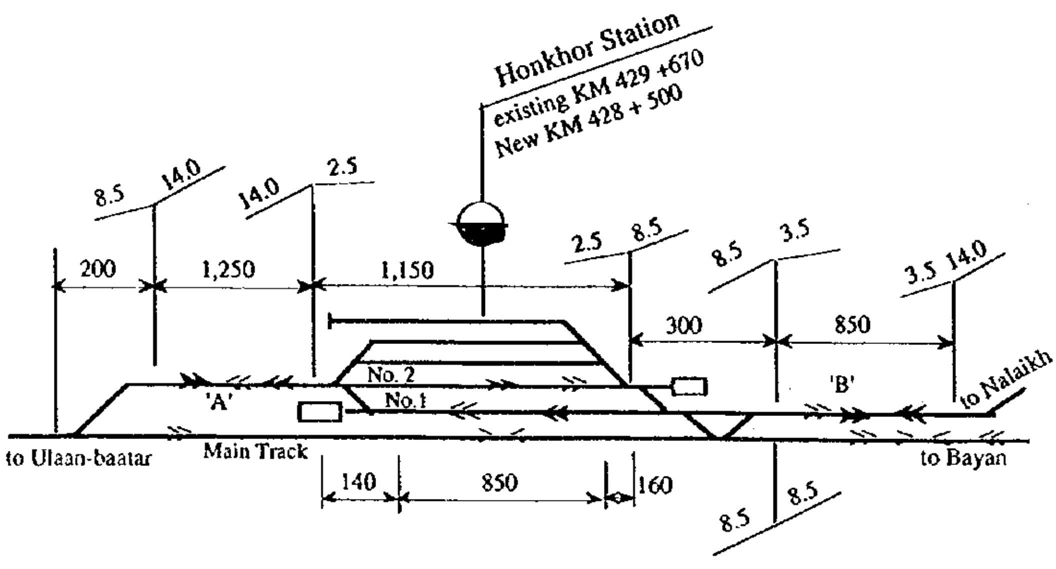


Fig. 3 Track Layout of New Honkhor Station

(5) Study of the Ruling Grade.

1) The Problems of Changes of the Ruling Grade.

The Mongolian Railway line has the sharpest grade of 18 ‰ at the starting point side at Ulaan-baatar between Tolgoit (Km 395)~ Emeelt (Km 378). When considering this grade, there are the opinions that the around area at the end side of the line from Ulaan-baatar should be adopted a steeper grade of more than the Ruling Grade 9‰.

As a general rule, when the railway location is being made to adapt to the natural terrain features, in the sectors where passenger trains are mainly running, it is the practice to use steeper grades that will not affect speed restrictions, and to use a larger radius on curves for the reduction of speed restriction. For the lines that are used mainly by freight trains, the practice is to improve fewer increasing speed than for the passenger trains. Thus, a smaller radius on curves which will not influence to the nominal tractive capacities will be adopted to conform with the terrain and a gentler grade will be used on the gradients which will influence them.

The present route adopts curves of 300m radius for using the steepest ruling grade of 9 ‰. If a ruling grade of 18 ‰ is used, a comparison of the relative merits will be as follows (Table 2):

Table 2 The Relative Merits of the Ruling Grade of 9 ‰ and 18 ‰

Item		9 ‰ Ruling Grade	18‰ Ruling Grade	Remarks
Route Selection Policy		Use min. radius of 600m longer track length, and grades less than 9 ‰.	Keep earthwork to a min. and make use of terrain, and select route for shortest and economic route.	General natural ground slope of area is approx. 16‰.
Passenger Train	Speed	Speed restriction for curves.	No limit for curve.	
	Frequency	Same as present.	Same as present.	
Freight Train	Nominal Tractive Capacity	2,600 ton	1,300 ton (1/2, 9 ‰ grade)	
	Equilibrium Speed	Approx. 20 km / h	Approx. 20 km / h	
	No. of Train	Same as present.	Increase train frequency or couple helper.	
	No. of Locomotive and Staff	Same as present.	Increase freight trains, staff and locomotive	JNR policy full tract principle until 1980s.
	Fuel	Same as present.	Increase	

NOTES: Sections that need improvement of curvature are Bayan ~ Hoolt, Hoolt ~ Tsgaan-hyar, Tsgaan-hyar ~ Hanga, and the change of the Ruling Grade have a linkage with the management policy of the Mongolian Railway and should be a matter for the Railway Management to study.

2) Gradient for Curve Compensation

The policy of the Mongolian Railway is that there is no necessity to compensate track curvature where the radius is larger than 500m. With the Japanese Railways the compensation of the curves is made regardless of the radius of the curves. Since the study is a preliminary study, this matter will not be pursued.

In Scheme 2 of this study, the rail level at the river crossings are lower than the river levels, if it is possible to make the grades at 9 ‰, it will permit easier selection of the new railway route. It is requested that a decision of this matter be clarified by the time that the survey work is completed.

(6) Investigation and Estimated Construction Costs

1) Necessity for the Investigation.

At the request of the Mongolian Railway the possibility of performing a route selection from the old contour plans was made roughly. However, this study was made for a rough check of the technical possibility, and from the data available it will not be possible to make an exact study which requires exact data of the topography, hydrology, and plant life of the area.

In order to make further studies in the future for the best route selection, and to perform the improvement work for the alternate route selection will require several years of study of the route, and the mandatory data required for this work are the topographical surveys, soils borings along the proposed route, and environmental studies to prevent degradation of land, water and air.

However, there are many matters that will help to accelerate and make the decision process easier, if they are resolved early. They are listed in the following:

① Decide the optimum maximum grade, the optimum minimum curvature (possible use of 18 ‰)

② The continued use of the Nalaikh Coal Mine or its close down, and any continued use as another facility.

③ The need for the Honkhor Station, the location, and its function on the railway line.

④ Change in the speed of trains with the change in the nominal tractive capacities if any.

⑤ Determine the super-elevation of track curve of R =300m, with a maximum cant of 150 mm, actual cant of 130 mm (calculated cant deficiency 140 mm).

2) Estimated Cost of Investigation and Surveying.

The main items of investigation are as follows:

① Soil Boring,	7 sites, each 10m deeps	Approx.	$ 20 thous.
② Field Survey,	1/2,500 topographic survey, approx. 45 km^2		100
③ Environmental Study,	Lump Sum		20
④ Technical Transfer,	Lump Sum		30
Total			170

During the course of the investigation, technical transfer of route selection shall be made to the Mongolian Railway technical staff so that they could perform the selection of railway routes by themselves.

3) Construction Implementation.

The construction work will consist of new construction of the alternate railway route for the Honkhor ~ Bayan Line, after which the work for the entry point to the Honkhor Station will be performed in staged construction.

Construction Period, approx. 3 years.

Total Construction Cost, approx. $ 40 mil.

Breakdown, Scheme 2, approx. $ 30 mil.

Breakdown, Scheme 3, approx. $ 10 mil.

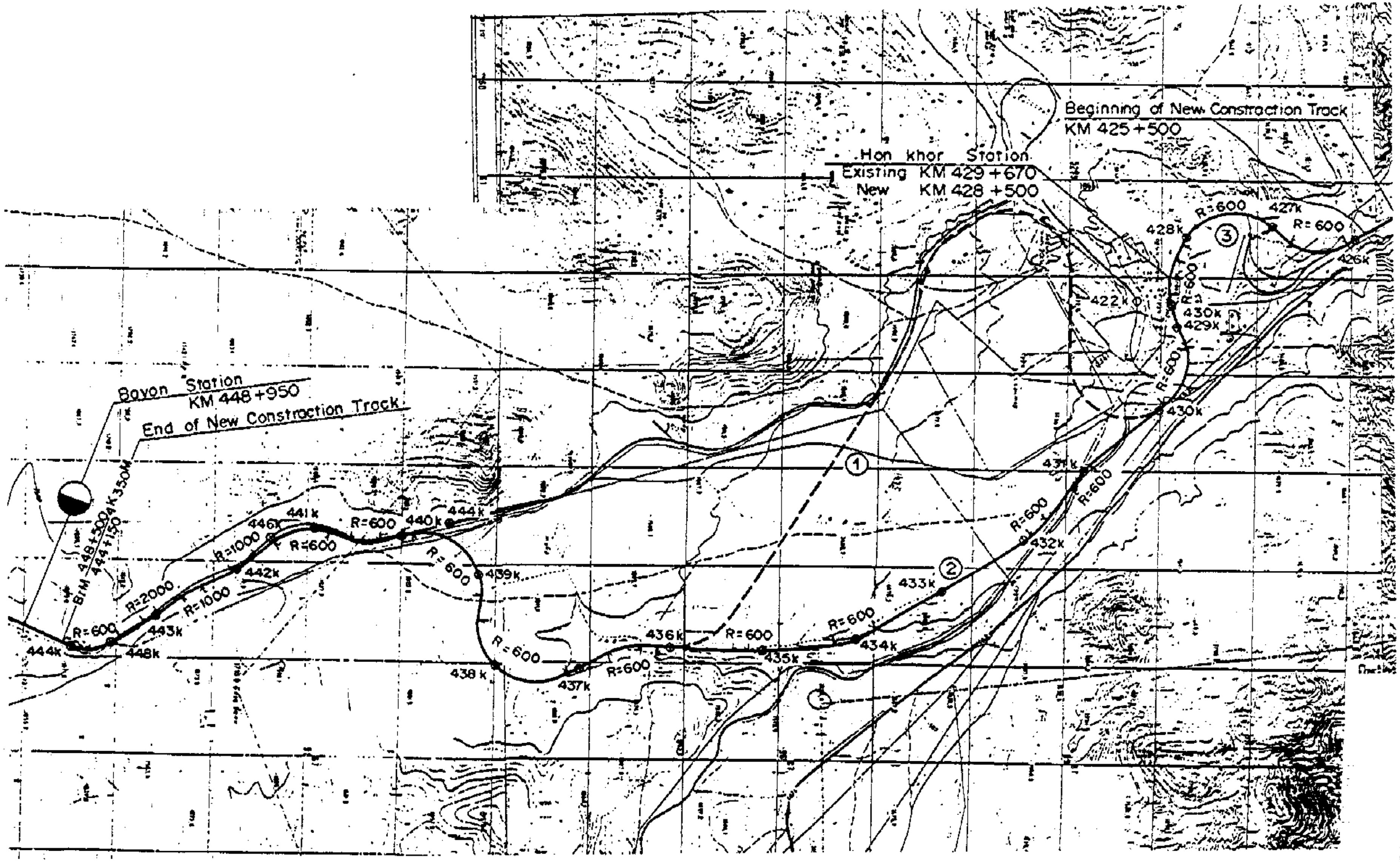


Fig. 11-1-3 Plofile between Hork hor and Bayan

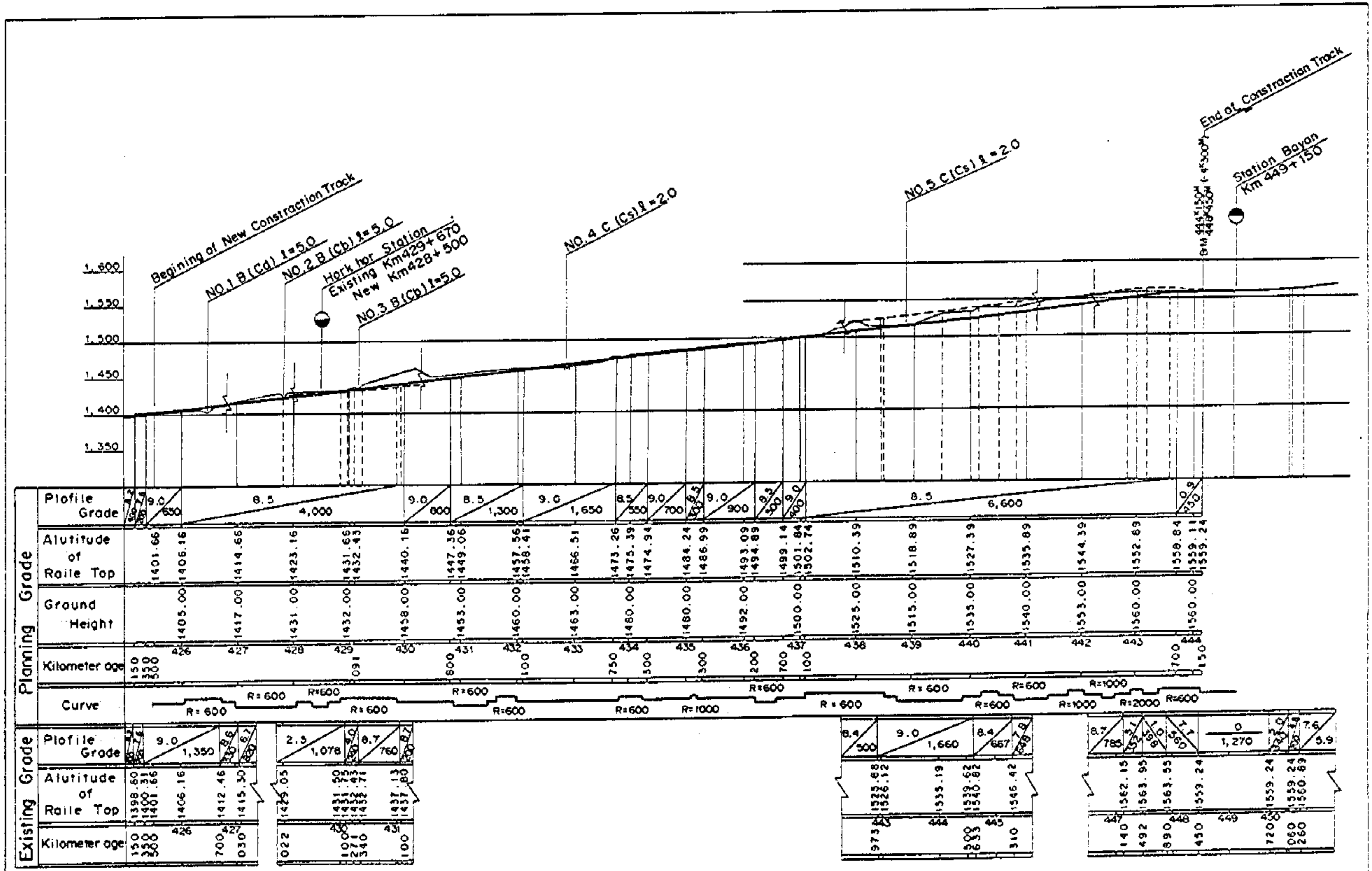


Fig. 11-1-2 Plan between Hork hor and Bayan

Appendix 8-4-1 Train operation regulation of Tokaido Shinkansen

(1) Restriction by rainfall amount

1) Stop the operation

One hour rainfall amount exceeds 50 mm /hour.

Continuos rainfall amount exceeds 150 mm and one hour rainfall amount exceeds 40 mm/hour.

2) Restrict train speed to 70 km /h

One hour rainfall amount exceeds 45 mm/hour

Continuous rainfall amount exceeds 150 mm and one hour rainfall amount exceeds 35 mm/hour.

(2) Restriction by wind

1) Stop the train operation

Wind velocity exceeds 30 m/sec

2) Restrict train speed to 120 km/h

Wind velocity exceeds 25 km/h

(3) Restriction by earthquake

Stop the train operation

Vibration exceeds 40 gal

Chapter 9

APPENDIX

Appendix 9-1

Table of Speed Limitation for Small-radius Curve (1)

	Position of Curve		Kind of Curve			Cant (A)	Difference of Permissive Cant	Cant Deficiency	Permissive Velocity of Cant (B)	Velocity for Actual Cant (C)	Difference	Difference	C=150, P=0.2m/sec^2 (Russian Rule)
No.	flom	to	Radius	Length	Velocity	$C=12.5*V^2/R$	150-(A)	120-(A)	$(R*150/12.5)^{1/2}$	$(R*120/12.5)^{1/2}$	V - (B)	V - (C)	$V=[(0.08*C+13P)*R]^{1/2}$
1	9,200	9k800m	298	605	65	177	-27	-57	60	53	5	12	66
2	9,900	10k700m	299	812	65	177	-27	-57	60	54	5	11	66
3	12,100	12k400m	300	348	65	176	-26	-56	60	54	5	11	66
4	12,400	13k200m	299	761	65	177	-27	-57	60	54	5	11	66
4'	12,400	13k200m	399	761	65	132	18	-12	69	62	-4	3	76
5	13,200	13k500m	295	217	65	179	-29	-59	59	53	6	12	66
6	14,700	15k100m	299	323	65	177	-27	-57	60	54	5	11	66
7	15,000	15k500m	292	375	65	181	-31	-61	59	53	6	12	65
8	15,500	15k700m	290	220	65	182	-32	-62	59	53	6	12	65
9	15,800	16k300m	300	455	65	176	-26	-56	60	54	5	11	66
10	16,300	16k700m	278	331	65	190	-40	-70	58	52	7	13	64
11	17,700	18k100m	300	398	65	176	-26	-56	60	54	5	11	66
12	18,100	18k400m	310	225	65	170	-20	-50	61	55	4	10	67
13	18,400	18k800m	299	410	65	177	-27	-57	60	54	5	11	66
14	19,400	19k700m	296	283	65	178	-28	-58	60	53	5	12	66
15	19,700	20k100m	300	381	65	176	-26	-56	60	54	5	11	66
16	20,200	20k600m	302	431	65	175	-25	-55	60	54	5	11	66
17	20,700	20k900m	325	218	65	163	-13	-43	62	56	3	9	69
18	21,200	21k500m	308	233	65	171	-21	-51	61	54	4	11	67
19	21,800	22k100m	300	230	65	176	-26	-56	60	54	5	11	66
20	50,700	50k900m	300	194	70	204	-54	-84	60	54	10	16	66
21	50,900	51k100m	335	160	70	183	-33	-63	63	57	7	13	70
22	52,500	53k300m	300	712	70	204	-54	-84	60	54	10	16	66
23	53,300	54k100m	299	813	70	205	-55	-85	60	54	10	16	66
24	54,800	55k200m	302	207	70	203	-53	-83	60	54	10	16	66
25	56,400	56k900m	300	417	70	204	-54	-84	60	54	10	16	66
26	56,900	57k200m	292	274	70	210	-60	-90	59	53	11	17	65
27	59,500	60k100m	297	441	70	206	-56	-86	60	53	10	17	66
28	60,100	60k400m	300	394	70	204	-54	-84	60	54	10	16	66
29	60,500	61k100m	299	448	70	205	-55	-85	60	54	10	16	66
30	64,400	64k900m	292	449	80	274	-124	-154	59	53	21	27	65
31	64,900	65k400m	298	495	80	268	-118	-148	60	53	20	27	66
32	82,100	82k300m	300	195	80	267	-117	-147	60	54	20	26	66
33	82,300	82k500m	305	150	80	262	-112	-142	60	54	20	26	67
34	87,100	87k400m	300	287	70	204	-54	-84	60	54	10	16	66
35	87,400	87k700m	300	312	70	204	-54	-84	60	54	10	16	66

Table of Speed Limitation for Small-radius Curve (2)

Position of Curve			Kind of Curve			Cant (A)	Difference of Permissive Cant	Cant Deficiency	Permissive Velocity of Cant (B)	Velocity for Actual Cant (C)	Difference	Difference	C=150, P=0.2m/sec^2 (Russian Rule)
No.	from	to	Radius	Length	Velocity	$C=12.5*V^2/R$	150-(A)	120-(A)	$(R*150/12.5)^{1/2}$	$(R*120/12.5)^{1/2}$	V-(B)	V-(C)	$V=[(0.08*C+13P)*R]^{1/2}$
36	145,300	145k800m	300	446	70	204	-54	-84	60	54	10	16	66
37	146,900	147k200m	293	237	70	209	-59	-89	59	53	11	17	65
38	147,300	147k500m	300	232	70	204	-54	-84	60	54	10	16	66
39	147,600	148k100m	298	472	70	206	-56	-86	60	53	10	17	66
40	148,100	148k400m	282	336	70	217	-67	-97	58	52	12	18	64
41	186,700	187k100m	300	434	80	267	-117	-147	60	54	20	26	66
42	187,200	187k500m	300	296	70	204	-54	-84	60	54	10	16	66
43	276,800	277k100m	295	258	70	208	-58	-88	59	53	11	17	66
44	279,100	279k200m	300	272	70	204	-54	-84	60	54	10	16	66
45	279,300	279k600m	300	330	70	204	-54	-84	60	54	10	16	66
46	287,700	288k700m	348	1051	70	176	-26	-56	65	58	5	12	71
47	289,100	289k900m	298	951	70	206	-56	-86	60	53	10	17	66
48	292,700	293k400m	299	666	70	205	-55	-85	60	54	10	16	66
49	299,800	300k300m	298	532	70	206	-56	-86	60	53	10	17	66
50	372,800	373k200m	300	320	70	204	-54	-84	60	54	10	16	66
51	373,400	374k100m	298	652	70	206	-56	-86	60	53	10	17	66
52	374,400	375k300m	298	965	70	206	-56	-86	60	53	10	17	66
53	378,300	378k800m	300	476	70	204	-54	-84	60	54	10	16	66
54	382,100	382k600m	298	616	70	206	-56	-86	60	53	10	17	66
55	382,800	383k600m	298	869	70	206	-56	-86	60	53	10	17	66
56	416,900	417k300m	300	402	70	204	-54	-84	60	54	10	16	66
57	417,900	418k200m	297	261	70	206	-56	-86	60	53	10	17	66
58	426,900	427k500m	299	505	70	205	-55	-85	60	54	10	16	66
59	427,500	427k900m	300	409	70	204	-54	-84	60	54	10	16	66
60	427,900	428k900m	298	961	70	206	-56	-86	60	53	10	17	66
61	430,300	431k500m	290	1220	70	211	-61	-91	59	53	11	17	65
62	433,500	434k100m	300	515	65	176	-26	-56	60	54	5	11	66
63	434,100	435k500m	299	1357	65	177	-27	-57	60	54	5	11	66
64	436,100	436k500m	300	557	65	176	-26	-56	60	54	5	11	66
65	437,400	437k600m	300	250	65	176	-26	-56	60	54	5	11	66
66	438,900	439k300m	300	434	70	204	-54	-84	60	54	10	16	66
67	448,100	448k300m	298	377	70	206	-56	-86	60	53	10	17	66
68	449,700	450k400m	300	681	70	204	-54	-84	60	54	10	16	66
69	450,400	450k900m	298	513	70	206	-56	-86	60	53	10	17	66
70	451,300	452k100m	300	801	65	176	-26	-56	60	54	5	11	66
71	452,200	452k400m	292	272	65	181	-31	-61	59	53	6	12	65

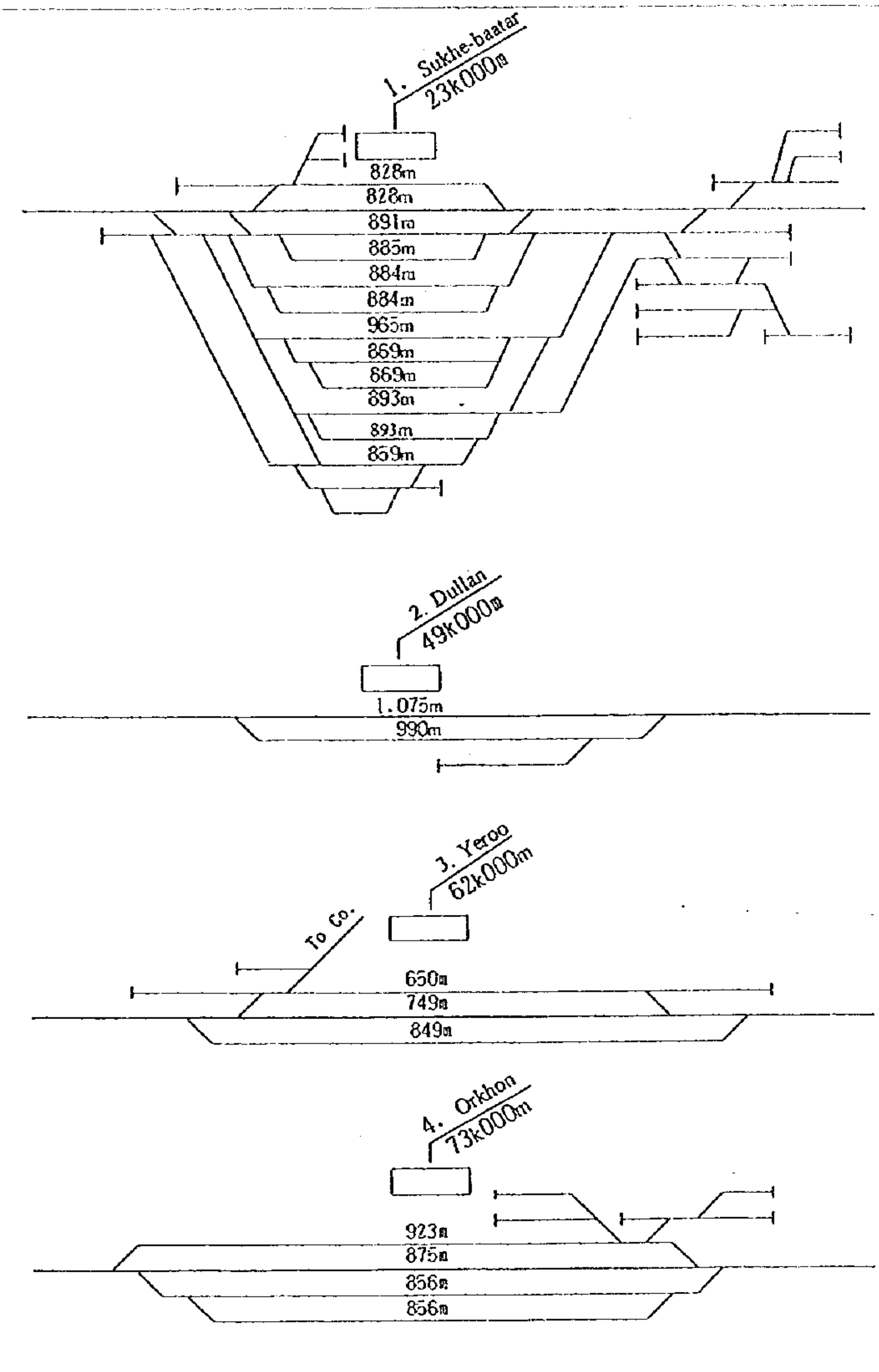
Table of Speed Limitation for Small-radius Curve (3)

Position of Curve			Kind of Curve			Cant (A)	Difference of Permissive Cant	Cant Deficiency	Permissive Velocity of Cant (B)	Velocity for Actual Cant (C)	Difference	Difference	C=150, P=0.2m/sec^2 (Russian Rule)
No.	flom	to	Radius	Length	Velocity	$C=12.5*V^2/R$	150-(A)	120-(A)	$(R*150/12.5)^{1/2}$	$(R*120/12.5)^{1/2}$	V - (B)	V - (C)	$V=[(0.08*C+13P)*R]^{1/2}$
72	452,600	452k800m	303	238	65	174	-24	-54	60	54	5	11	67
73	452,800	453k100m	297	238	65	178	-28	-58	60	53	5	12	66
774	453,100	454k300m	299	1226	65	177	-27	-57	60	54	5	11	66
75	454,300	455k100m	299	694	65	177	-27	-57	60	54	5	11	66
76	455,100	455k500m	296	421	65	178	-28	-58	60	53	5	12	66
77	455,600	455k800m	300	197	65	176	-26	-56	60	54	5	11	66
78	455,900	456k300m	308	411	65	171	-21	-51	61	54	4	11	67
79	456,300	456k800m	300	501	65	176	-26	-56	60	54	5	11	66
80	456,900	457k400m	300	490	65	176	-26	-56	60	54	5	11	66
81	457,400	457k600m	301	202	65	175	-25	-55	60	54	5	11	66
82	457,600	457k900m	302	248	65	175	-25	-55	60	54	5	11	66
83	457,900	458k100m	308	226	65	171	-21	-51	61	54	4	11	67
84	459,400	460k100m	293	623	65	180	-30	-60	59	53	6	12	65
85	460,100	460k500m	299	401	65	177	-27	-57	60	54	5	11	66
86	460,500	460k800m	302	321	65	175	-25	-55	60	54	5	11	66
87	460,800	461k200m	300	401	65	176	-26	-56	60	54	5	11	66
88	461,200	462k200m	299	834	65	177	-27	-57	60	54	5	11	66
89	462,200	463k100m	299	834	65	177	-27	-57	60	54	5	11	66
90	463,200	463k300m	310	148	65	170	-20	-50	61	55	4	10	67
91	463,400	463k800m	298	376	65	177	-27	-57	60	53	5	12	66
92	463,800	464k100m	300	221	65	176	-26	-56	60	54	5	11	66
93	464,100	464k500m	297	411	65	178	-28	-58	60	53	5	12	66
94	464,500	465k100m	299	576	65	177	-27	-57	60	54	5	11	66
95	465,000	466k400m	298	456	65	177	-27	-57	60	53	5	12	66
96	465,100	465k600m	301	460	65	175	-25	-55	60	54	5	11	66
97	465,700	465k900m	330	142	65	160	-10	-40	63	56	2	9	69
98	466,400	466k600m	310	189	65	170	-20	-50	61	55	4	10	67
99	467,800	467k900m	310	181	65	170	-20	-50	61	55	4	10	67
100	468,100	468k200m	308	226	65	171	-21	-51	61	54	4	11	67
101	468,300	468k600m	300	249	65	176	-26	-56	60	54	5	11	66
102	472,700	473k600m	299	869	65	177	-27	-57	60	54	5	11	66
103	473,700	474k700m	299	1027	65	177	-27	-57	60	54	5	11	66
104	475,600	475k900m	300	233	65	176	-26	-56	60	54	5	11	66
105	477,100	477k200m	300	213	65	176	-26	-56	60	54	5	11	66
106	477,300	477k800m	300	522	65	176	-26	-56	60	54	5	11	66
107	477,800	478k300m	298	457	65	177	-27	-57	60	53	5	12	66

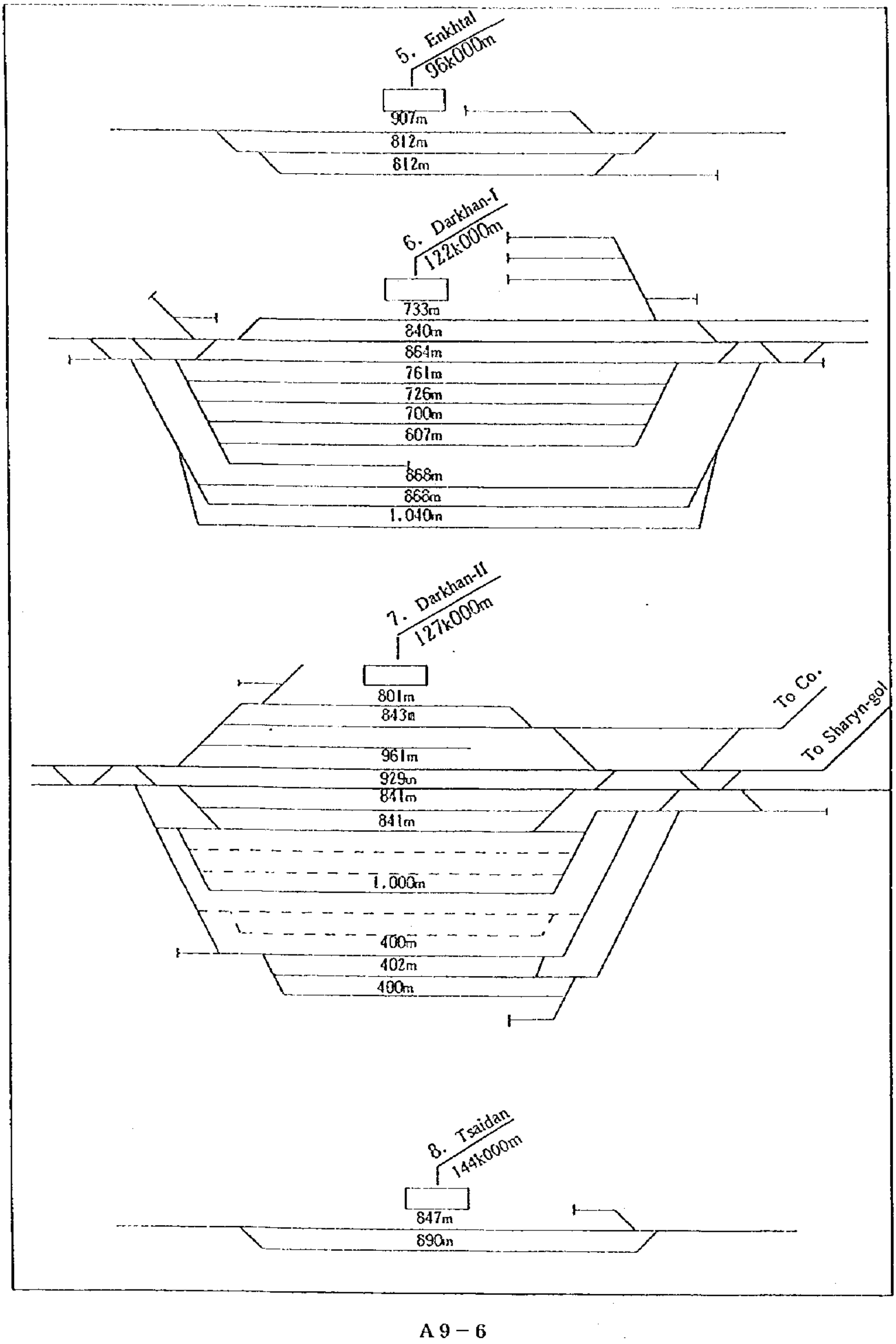
Table of Speed Limitation for Small-radius Curve (4)

Position of Curve			Kind of Curve			Cant (A)	Difference of Permissive Cant	Cant Deficiency	Permissive Velocity of Cant (B)	Velocity for Actual Cant (C)	Difference	Difference	C=150, P=0.2m/sec^2 (Russian Rule)
No.	from	to	Radius	Length	Velocity	$C=12.5*V^2/R$	150-(A)	120-(A)	$(R*150/12.5)^{1/2}$	$(R*120/12.5)^{1/2}$	V - (B)	V - (C)	$V=[(0.08*C+13P)*R]^{1/2}$
108	478,300	479k200m	299	853	65	177	-27	-57	60	54	5	11	66
109	479,400	480k200m	300	838	65	176	-26	-56	60	54	5	11	66
110	482,400	482k700m	302	274	65	175	-25	-55	60	54	5	11	66
111	482,700	483k100m	302	301	65	175	-25	-55	60	54	5	11	66
112	483,400	483k900m	296	374	65	178	-28	-58	60	53	5	12	66
113	484,300	484k800m	300	485	65	176	-26	-56	60	54	5	11	66
114	485,600	486k200m	300	657	65	176	-26	-56	60	54	5	11	66
115	905,200	905k900m	298	788	70	206	-56	-86	60	53	10	17	66
116	1,022,100	1022k600m	304	558	60	148	2	-28	60	54	0	6	67
117	1,022,600	1022k900m	312	316	60	144	6	-24	61	55	-1	5	67
118	1,028,100	1028k900m	300	810	60	150	0	-30	60	54	0	6	66
119	1,029,100	1030k100m	297	910	60	152	-2	-32	60	53	0	7	66
120	1,030,100	1030k400m	309	340	60	146	4	-26	61	54	-1	6	67
121	1,030,600	1031k100m	299	396	60	151	-1	-31	60	54	0	6	66

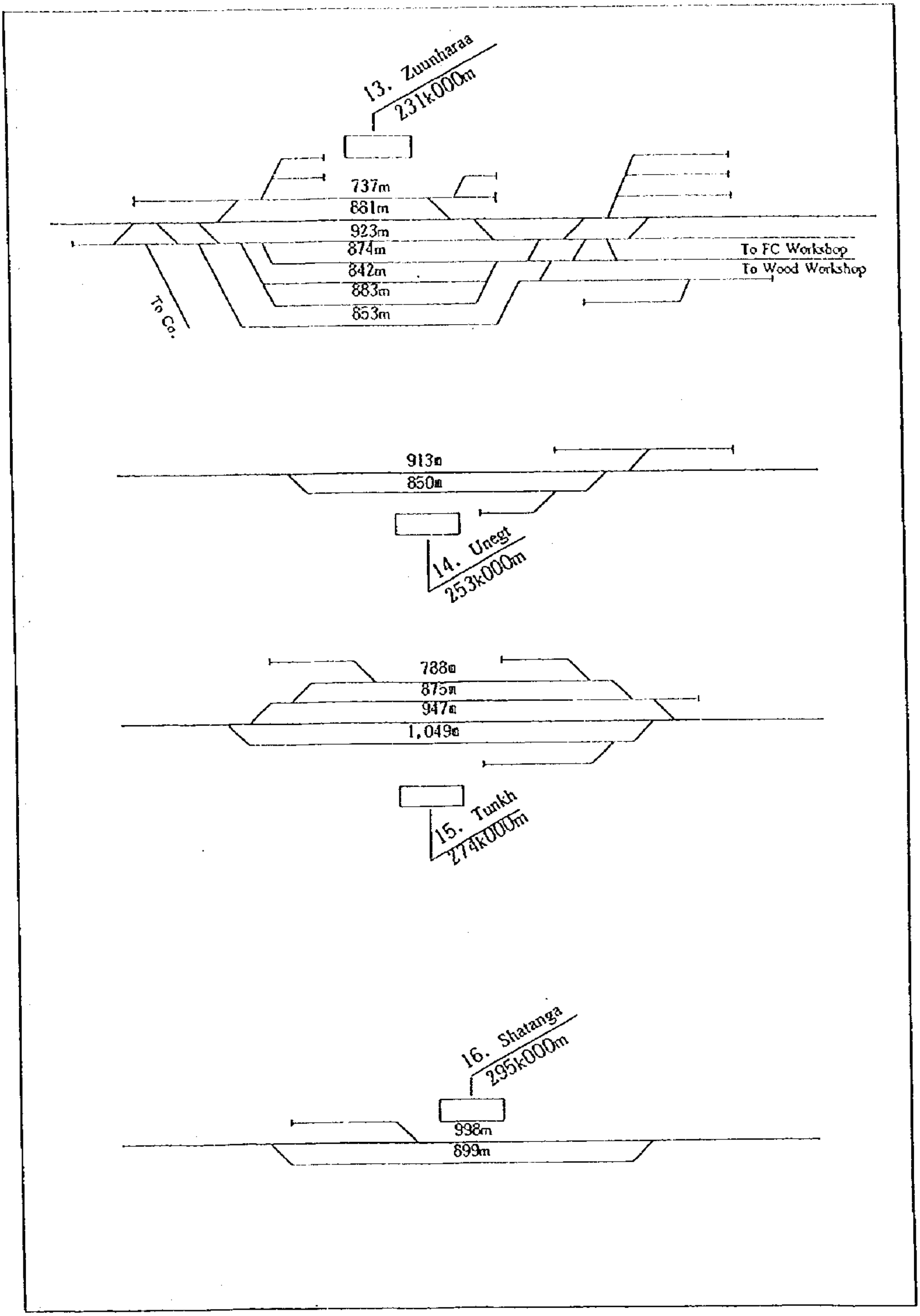
Appendix 9-2 Layout of Station in Mongolian Railway (1)



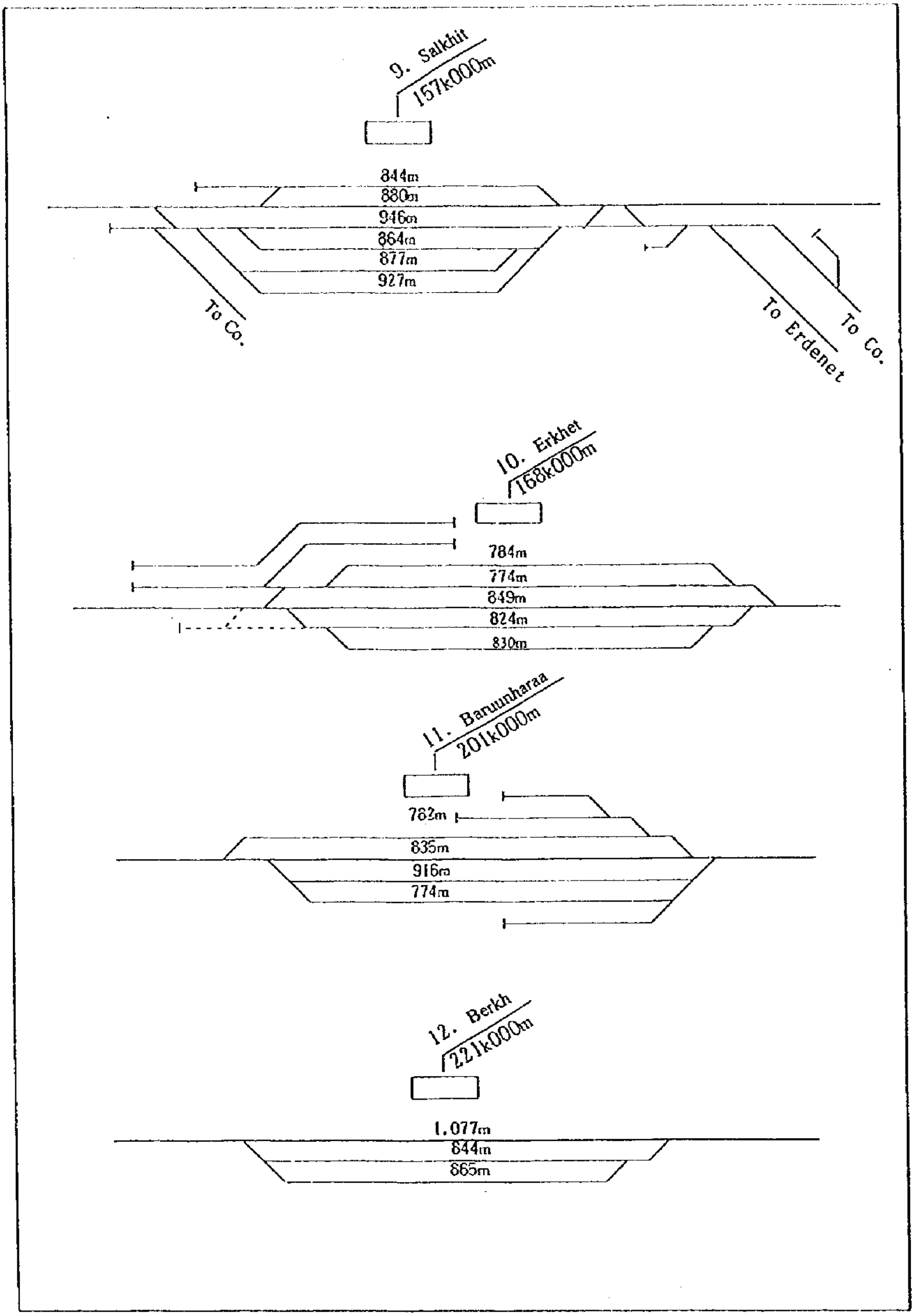
Layout of Station in Mongolian Railway (2)



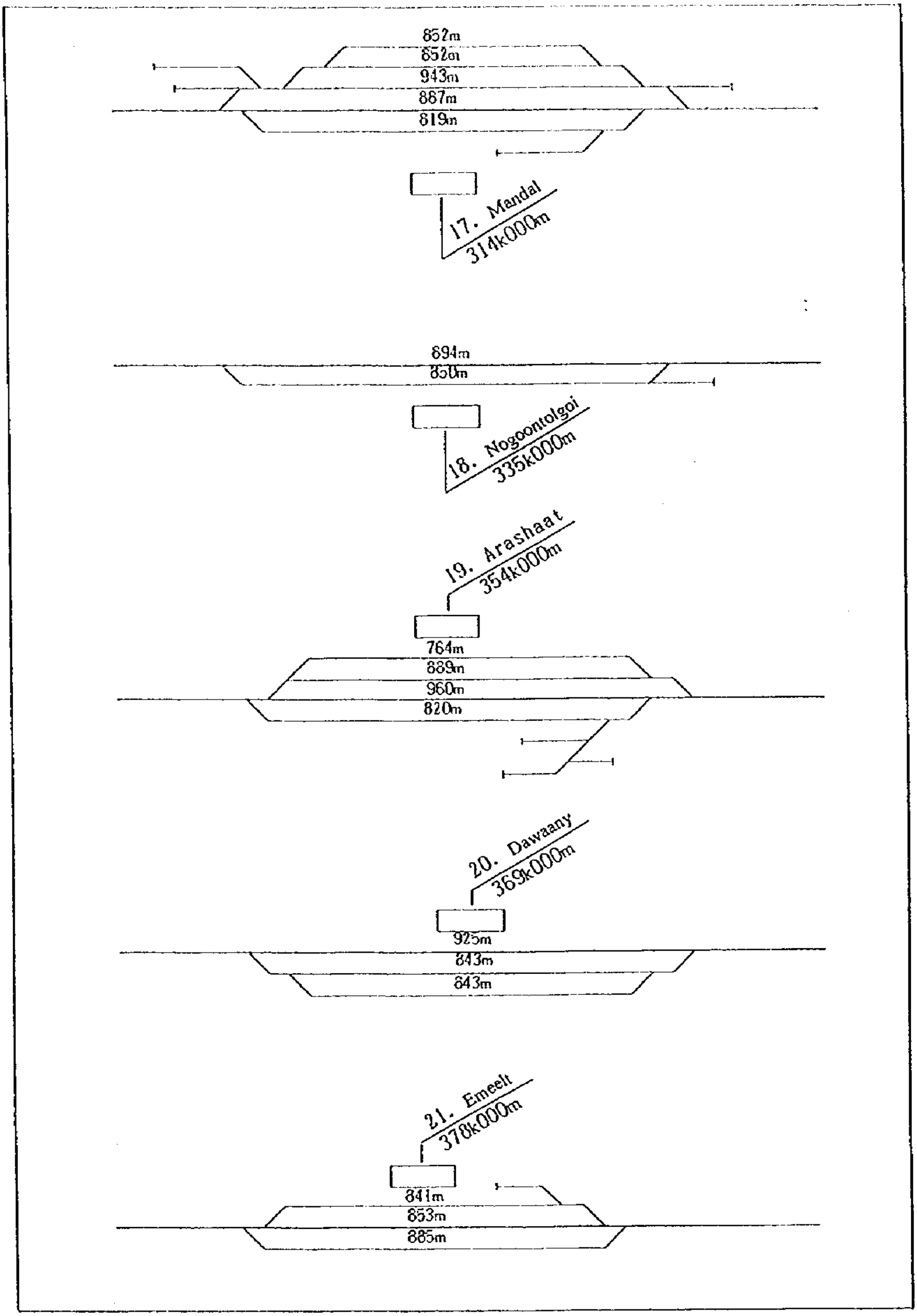
Layout of Station in Mongolian Railway (3)

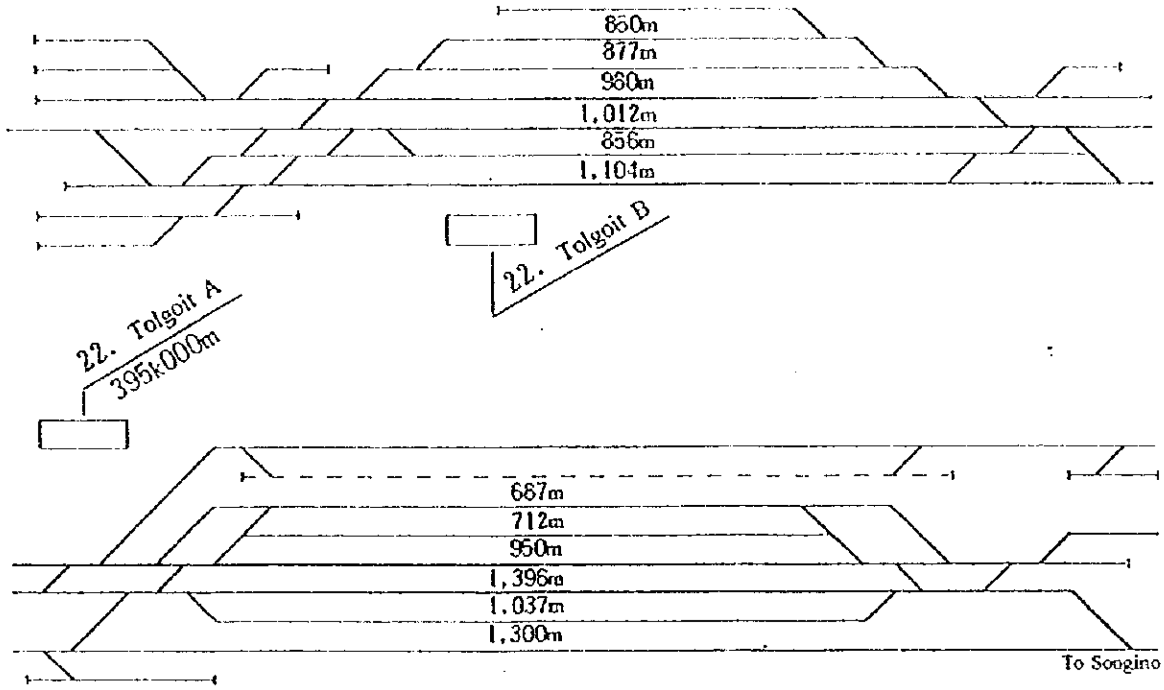


Layout of Station in Mongolian Railway (4)

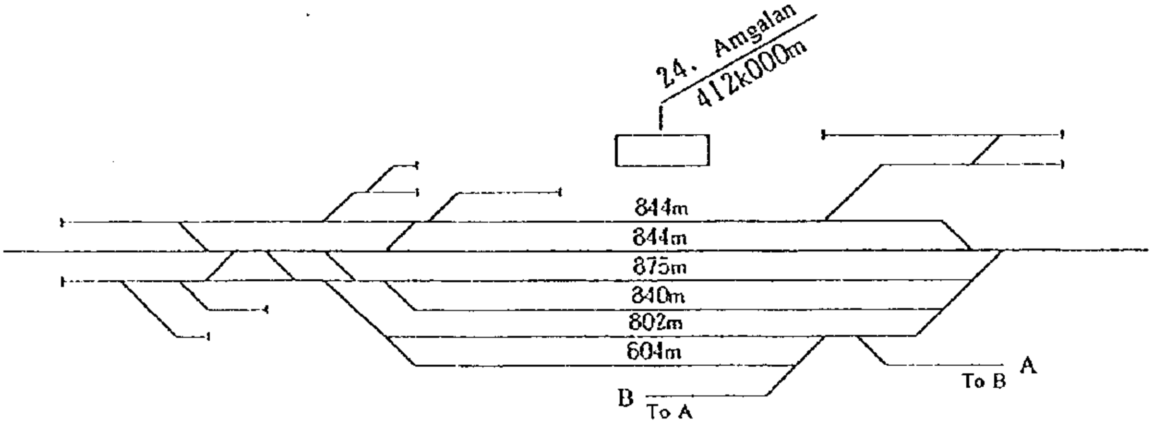


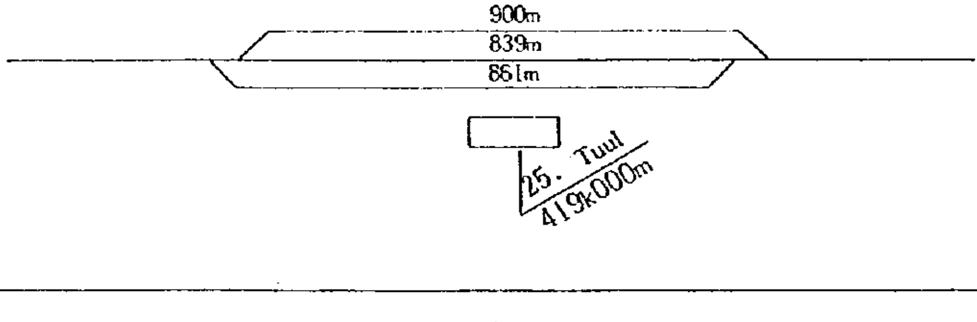
Layout of Station in Mongolian Railway (5)

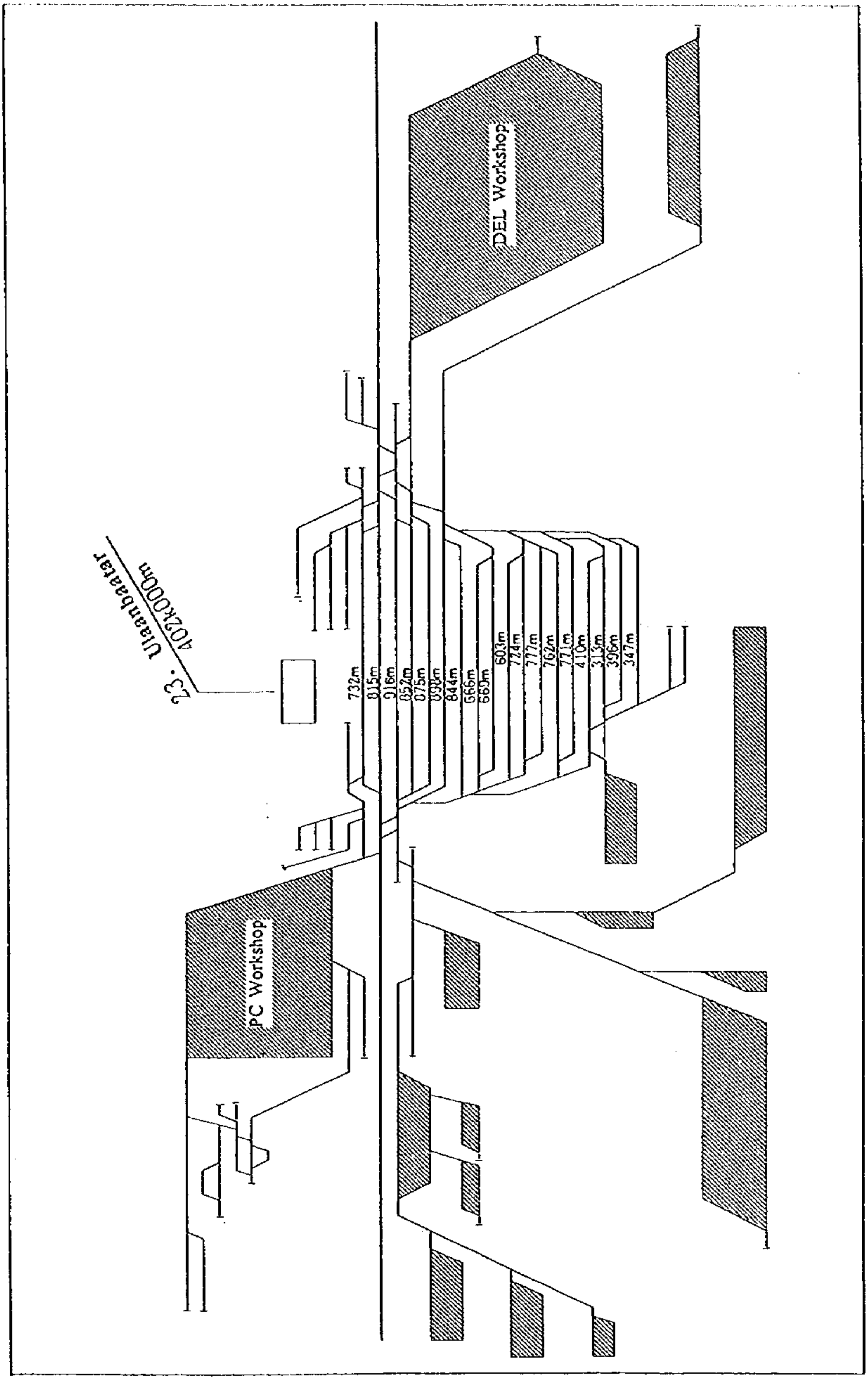




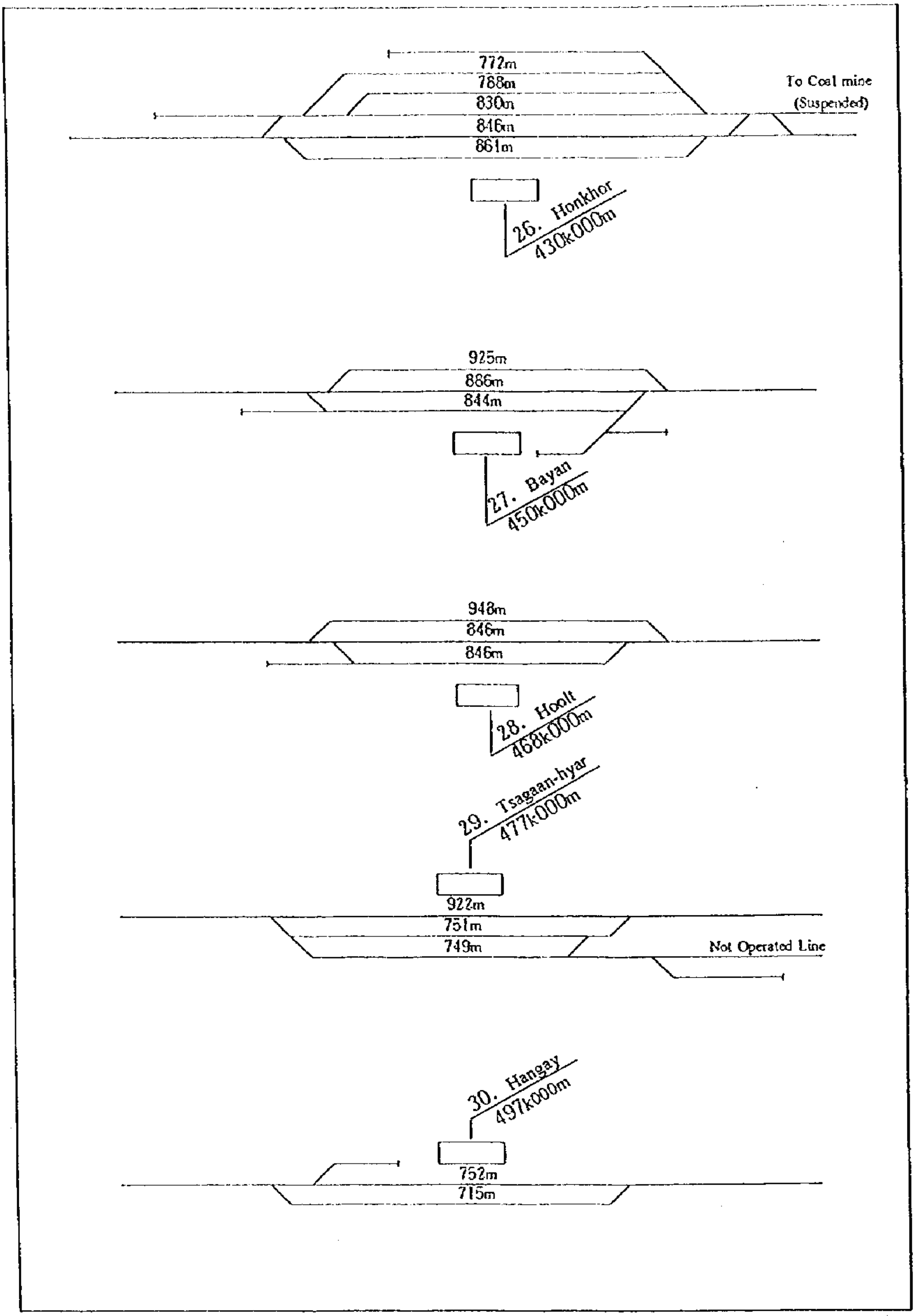
23. Ulaanbaatar (Next Page)



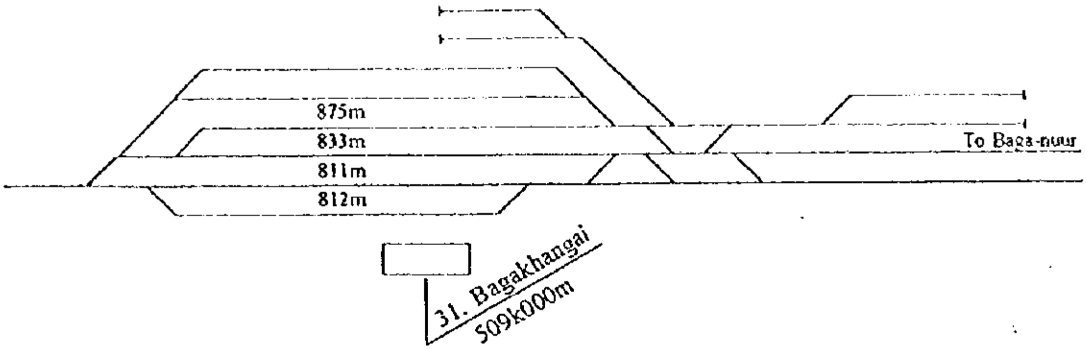


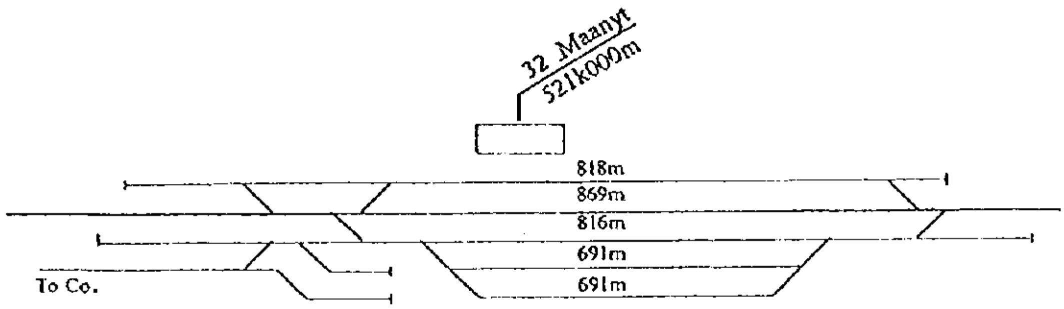

23 · Ulaanbaatar
402K000m
DEL Workshop
PC Workshop
732m
852m
844m
666m
603m
724m
777m
762m
771m
410m
313m
396m
347m

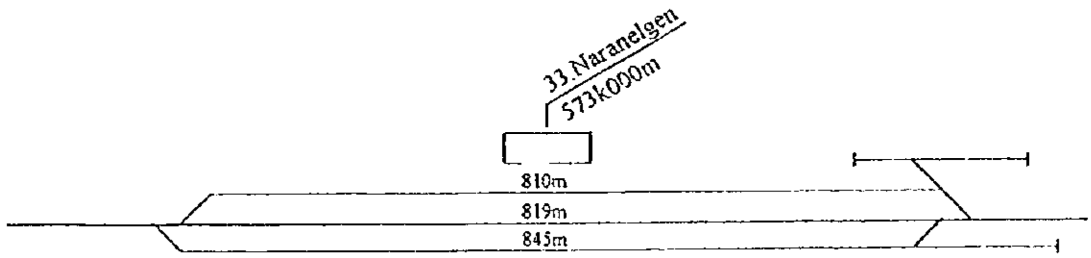
Layout of Station in Mongolian Railway (8)

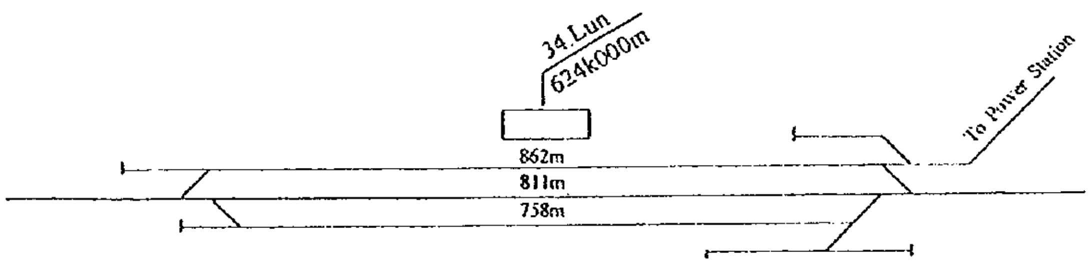


Layout of Station in Mongolian Railway (9)

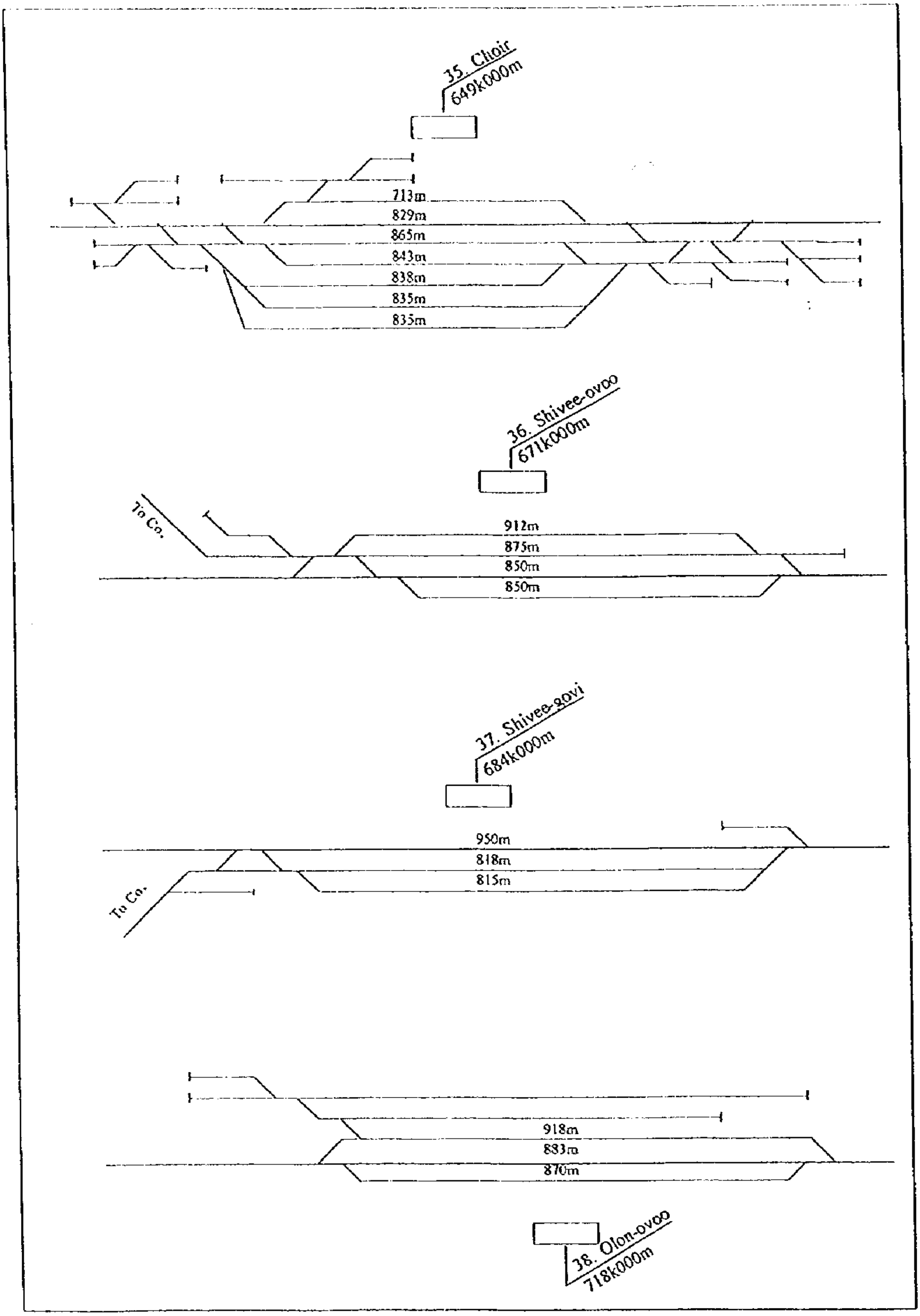




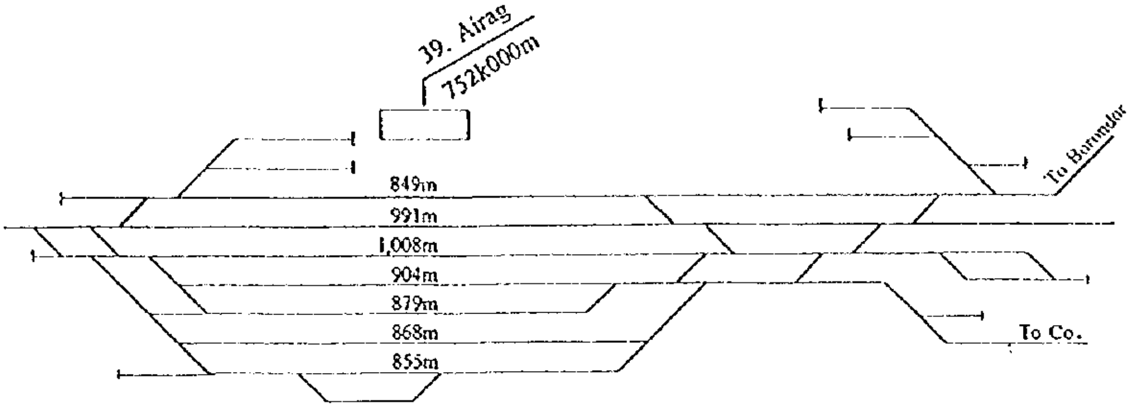


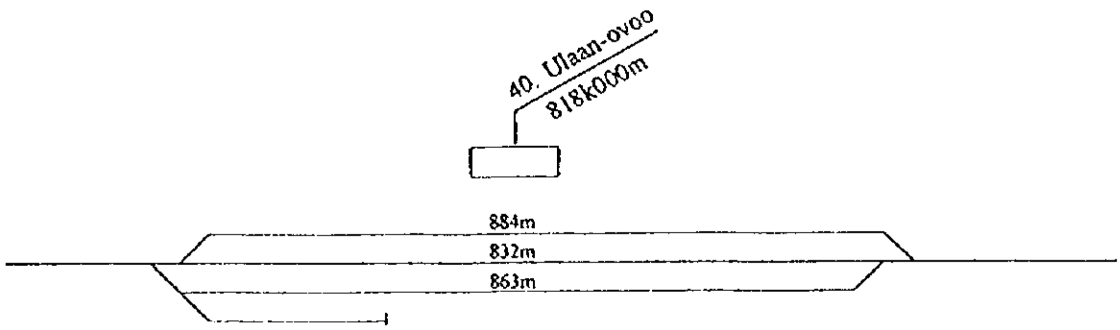


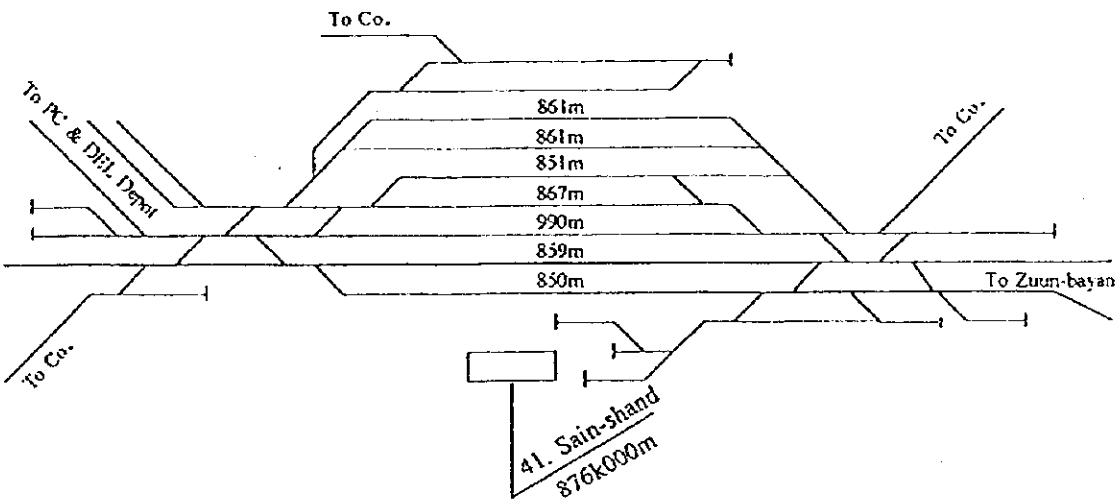
Layout of Station in Mongolian Railway (10)

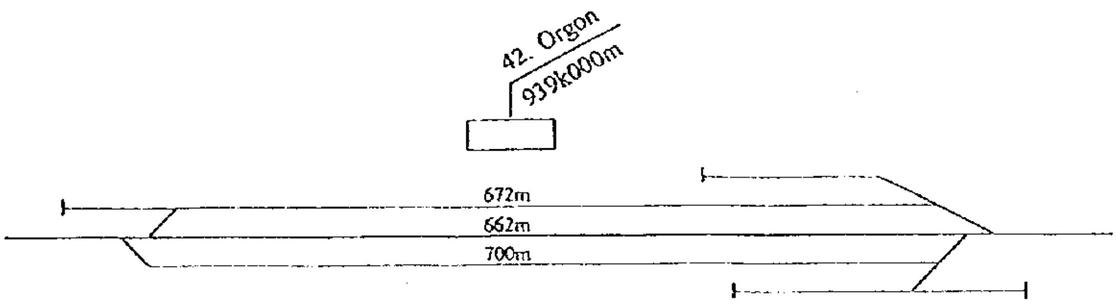


Layout of Station in Mongolian Railway (11)

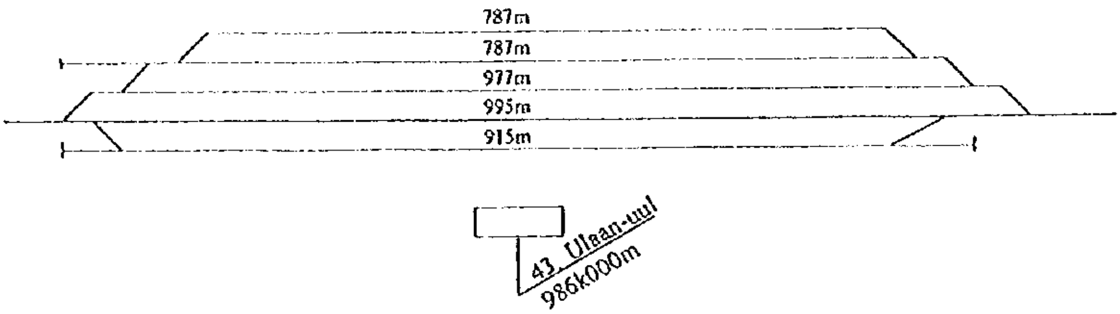


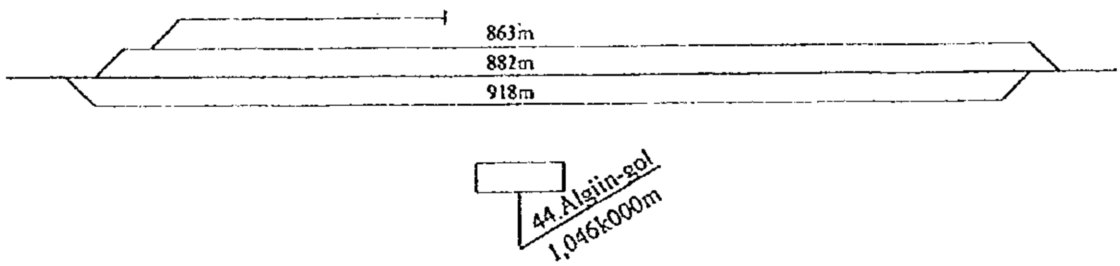


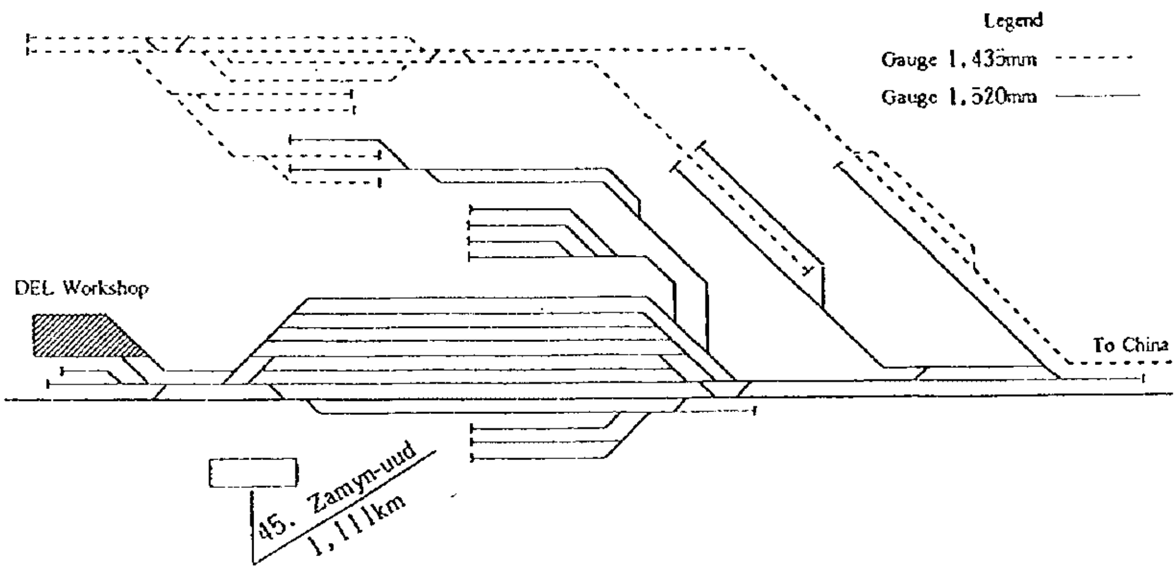




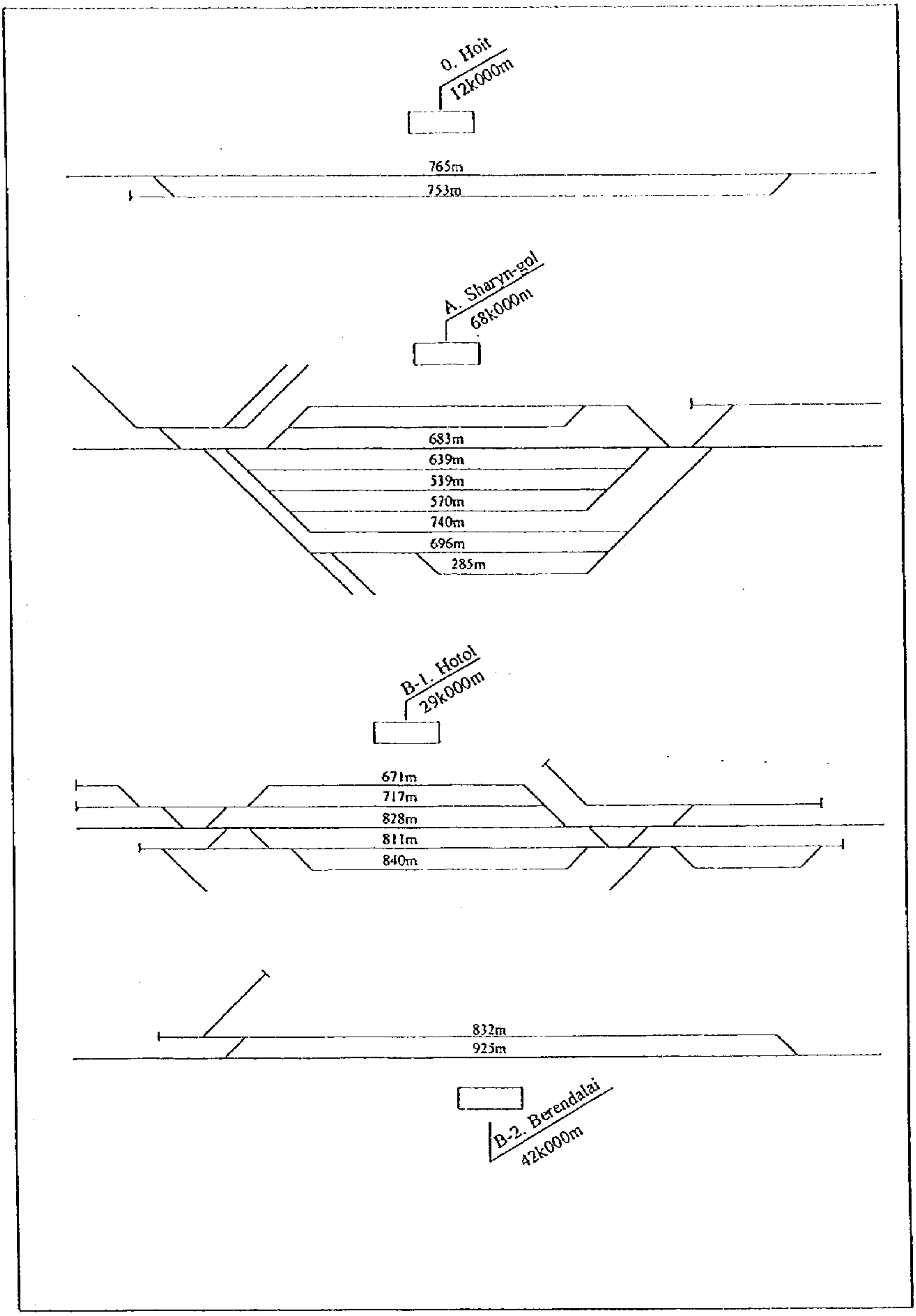
Layout of Station in Mongolian Railway (12)



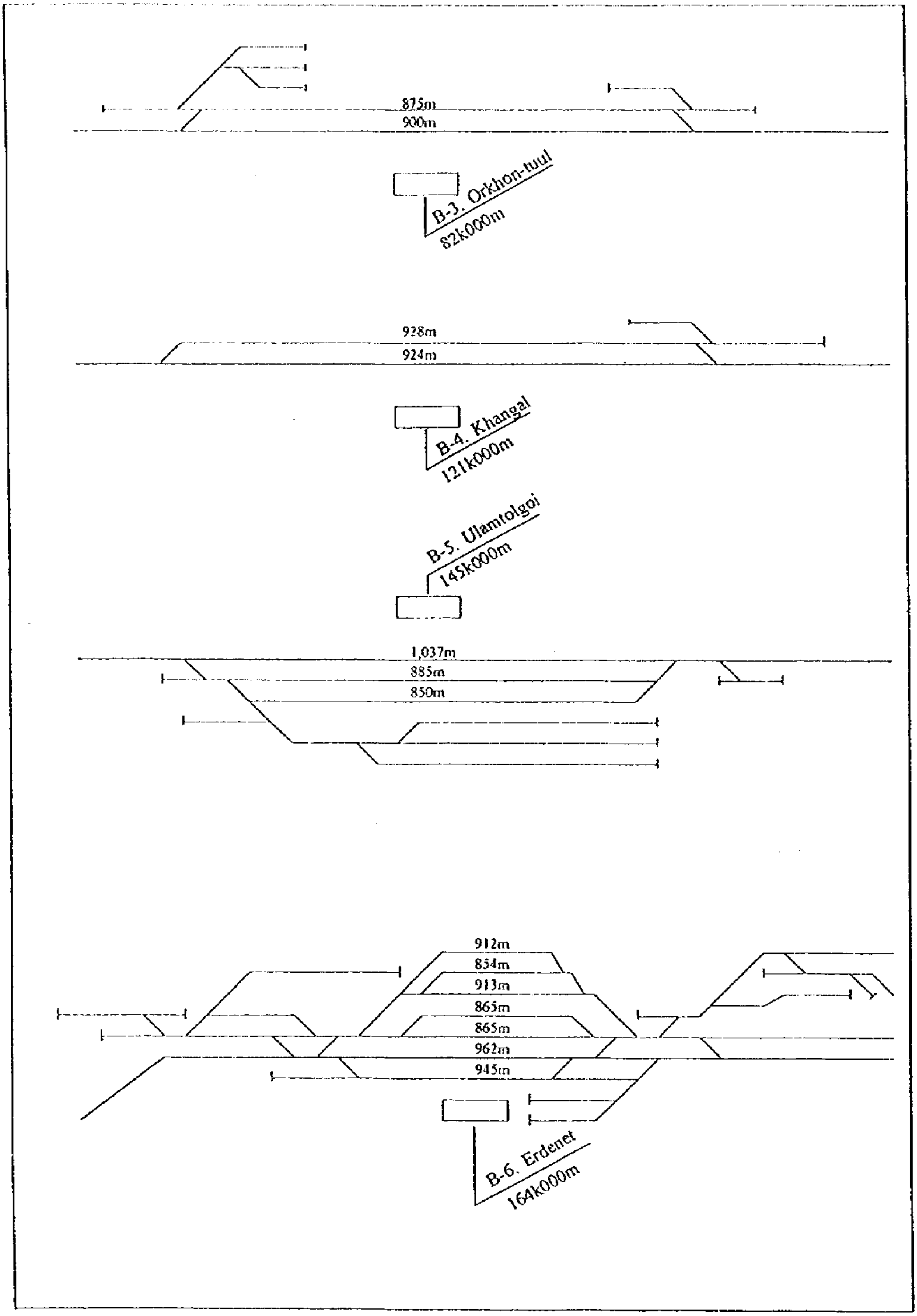




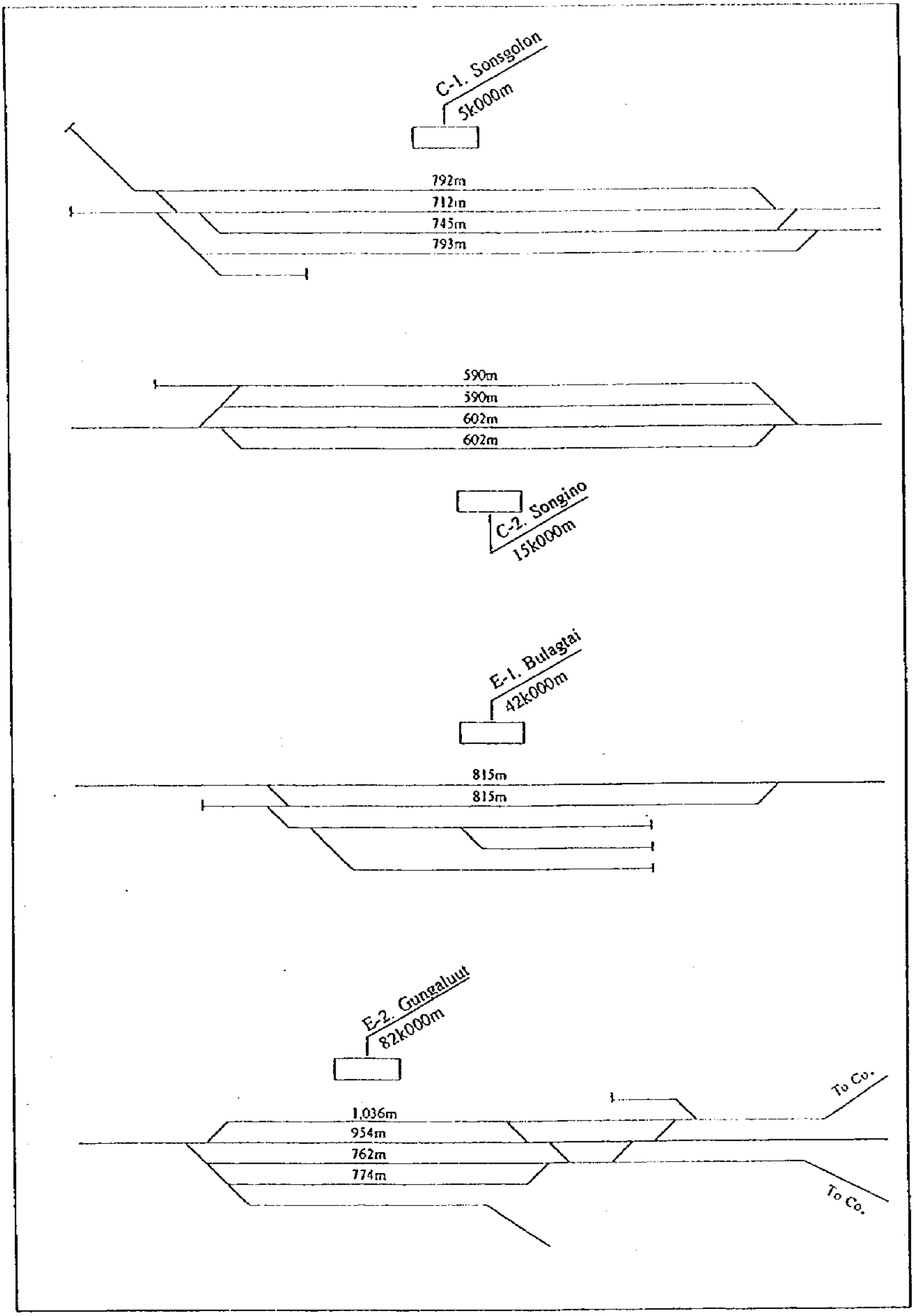
Layout of Station in Mongolian Railway (13)



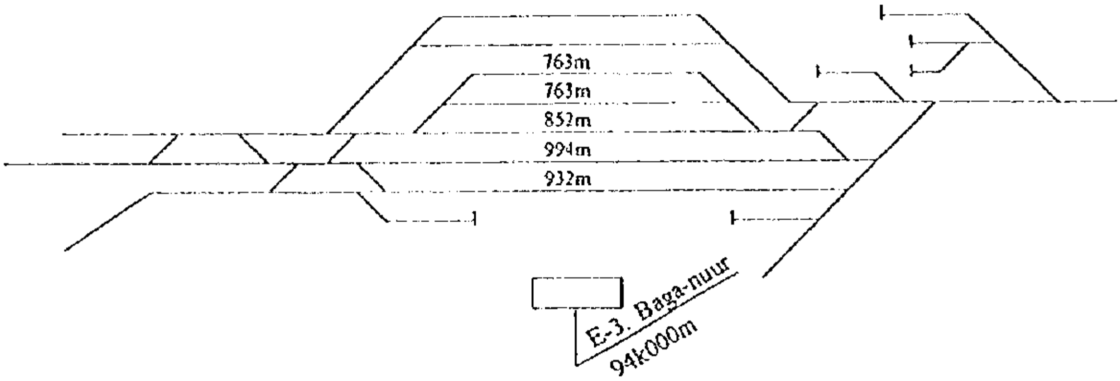
Layout of Station in Mongolian Railway (14)

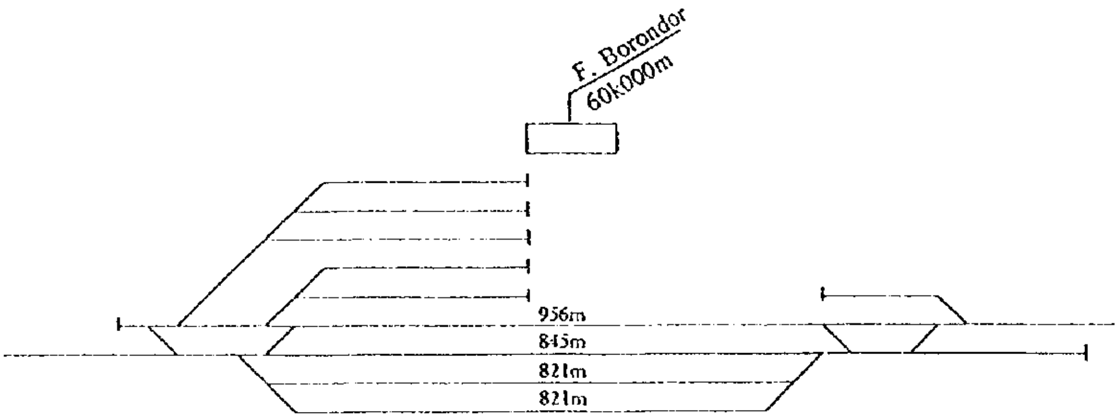


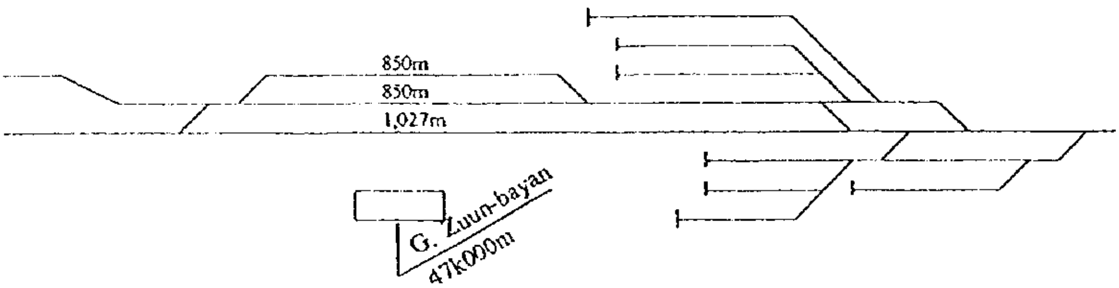
Layout of Station in Mongolian Railway (15)



Layout of Station in Mongolian Railway (16)







Chapter 10

APPENDIX

Appendix10-1 Project for a Electric Facility

Projects for providing optical fiber cables, replacing existing analog exchange units with digital units, and improting a computer system for the Mongolian Railway.

(1) Installation of optical Fiber Cables

The Mongolian Railway has set up a plan for providing carrier transmission systems using optical fiber cables. This project provides for optical carrier transmission systems, 150 Mbps (equivalent to 2,010ch of analog system), for the main line between Sukhe-baatar and Ulaan-baatar and that between Ulaan-baatar and Zamyn-uud.

(2) Replacement of Analog Exchange Unit by Digital System

The first phase this project has already been completed (refer to the exchange unit in the main text), and the second phase project is to be carried out.

(3) Import of Computer System

The Mongolian Railway has imported computers to construct a local area network (LAN)and is ready to start computerization of all cargo and freight infomation. Test operation of the new system is scheduled to begin in September 1996. Computers have beeninported for the stations listed in the following table.

App. Table 10-1

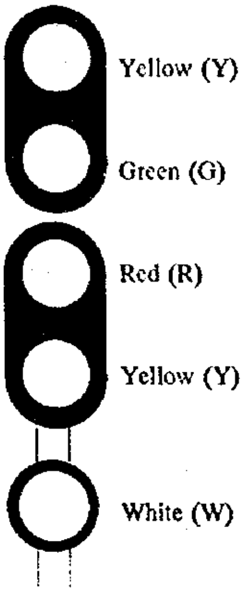
No.	Route map	System Allocation in Station					
		Station Name	Freight office	Technical offic	Station Dispatcher	Transit officer	Total
1	1	Sukhe-baatar		1	1	1	3
2	6	Darkhan-1	1	1	1		3
3	7	Darkhan-2	1		1		2
4	A	Sharyn-gol	1		1		2
5	9	Salkhit		1		1	1
6	B-1	Hotol		1		1	1
7	B-6	Erdenet	1		1		2
8	13	Zuunharaa	1	1	1		3
9	23	Ulaan-baatar	1	1	1		3
10	22	Tolgoit	1	1	1		3
11	31	Bagakhangai			1		1
12	E-3	Baga-nuur	1		1		2
13	32	Maanyt	Cancelled				
14	35	Choir	1		1		2
15	39	Airag	1		1		2
16	F	Borondor	Cancelled				
17	41	Sain-shand	1		1		2
18	45	Zamyn-uud	1	1		1	3
19	36	Shivee-ovoo	1				1
20		Train dispatcher (HeadQuater)	Cancelled				
21		Network center			2		2
22		Server Statistical Center		1	16	1	16
		Total	13	6	34	2	55

- Personal Computers (Made in Siemens, Germany)
- Printer (Page or Dot-matrix printer)
- Modem (modulator/demodulator)
- UPS (uninterruptible power supply unit)

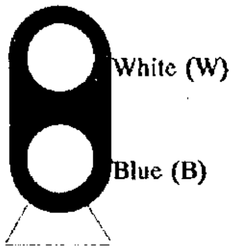
Appendix 10-2 Signal equipment and Signal indication systems

1. Signal Equipment

Departure and Entry Signals



Shunting Signals



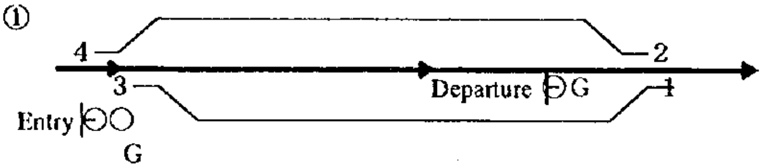
B (Blue :stop aspect)

G (Green : proceed aspect)
Y (Yellow: caution aspect)
R (Red : stop aspect)

2. Signal Indication and Locking of Points

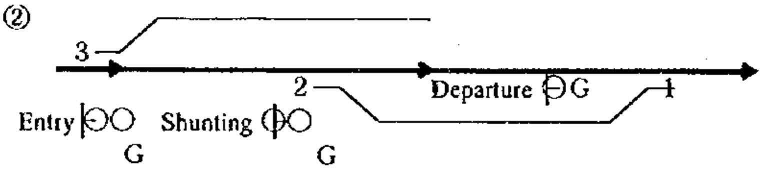
(1) Various Signal Indication Patterns

①



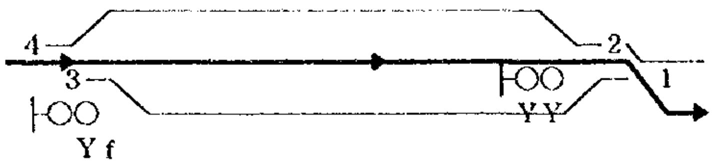
Lock points 3 and 4 by entry signal.
Lock points 1 and 2 by departure signal.

②



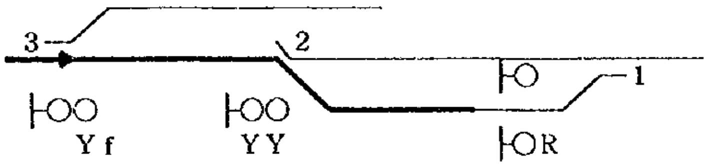
Lock points 3 by entry signal.
Lock points 2 by shunting signal.
Lock points 1 by departure signal.

③



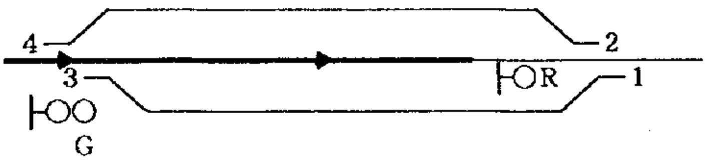
Lock points 3 and 4 by entry signal.
Lock points 1 and 2 by departure signal.

④



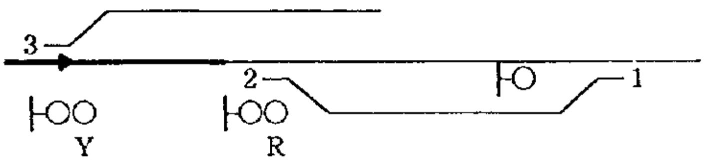
Lock points 3 by entry signal.
Lock points 2 by shunting signal.
Do not Lock by departure signal.

⑤



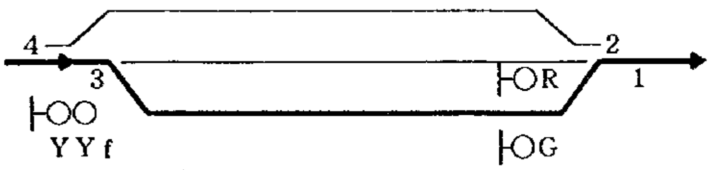
Lock points 3 and 4 by entry signal but do not Lock points 1 and 2.

⑥



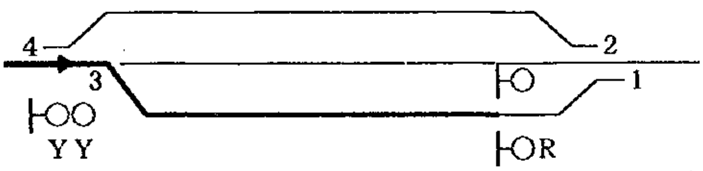
Lock points 3 by entry signal but do not Lock points 1 and 2.

⑦



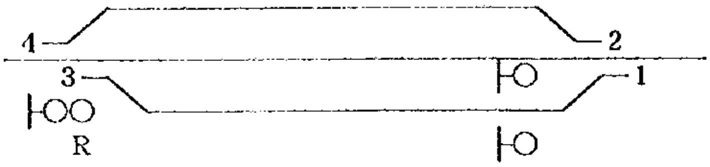
Lock points 3 and 4 by entry signal.
Lock points 1 and 2 by departure signal.

⑧



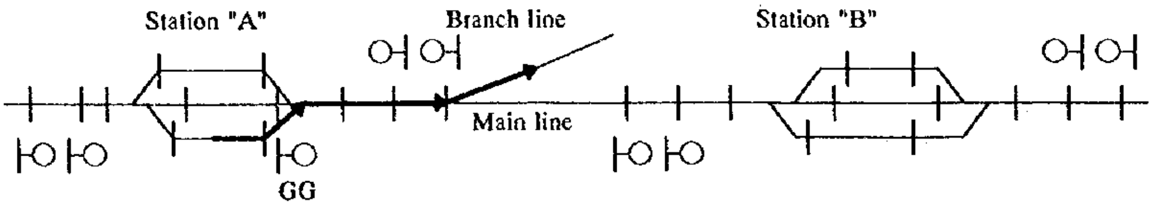
Lock points 3 and 4 by entry signal but do not Lock points 1 and 2.

⑨

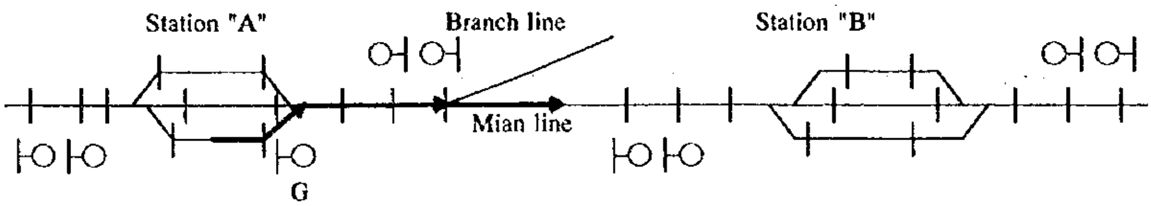


Y f : Y – FLASH (yellow signal flash)

(2) At times GG is indicated on departure signal.
At times train is entering into branch line.

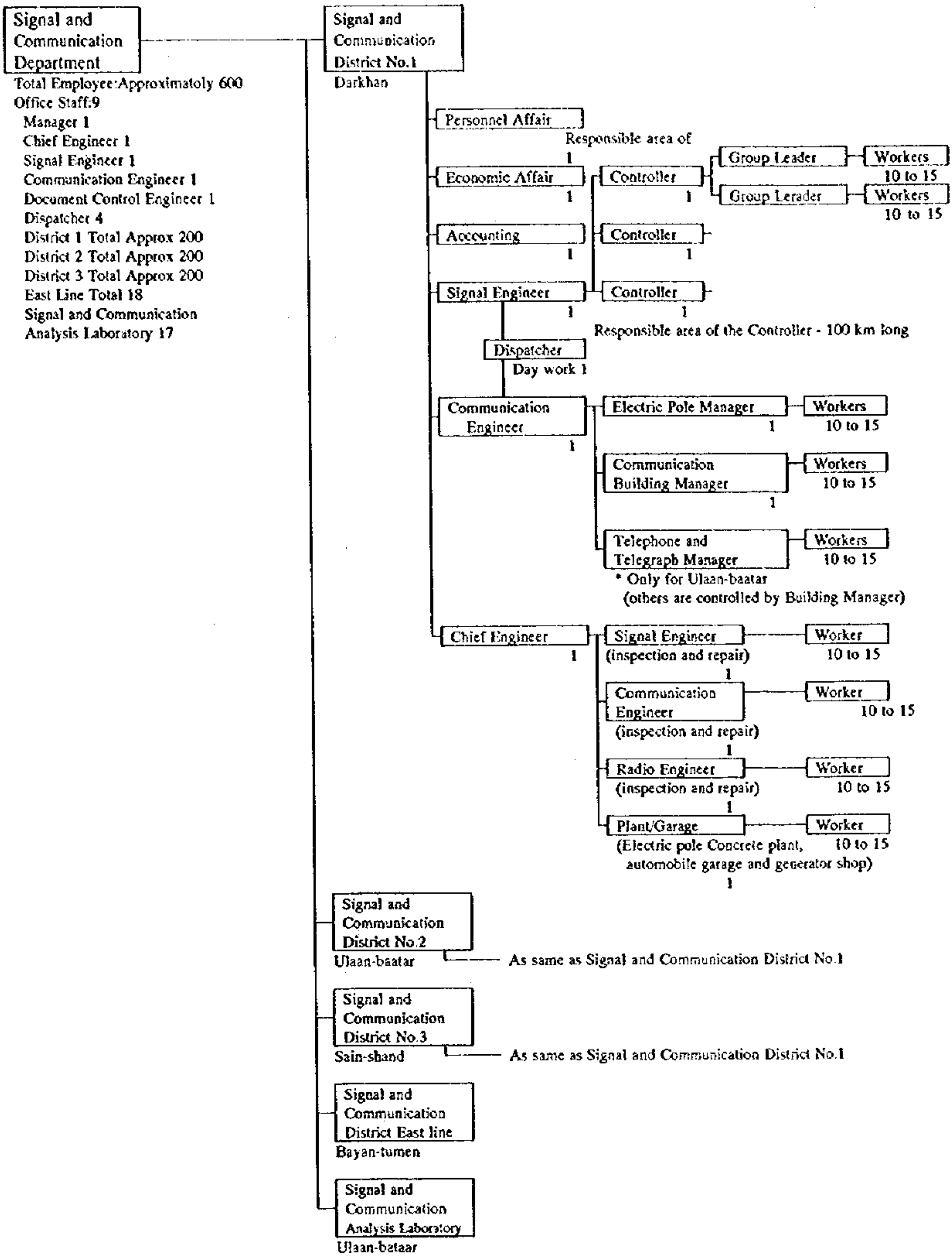


(3) At times G is indicated on departure signal.
At times train is entering into main line.



Appendix 10-3

Signal and Communication Department Organization Chart (September 1996)



Appendix 10-4

Power and Water Supply Department Organization Chart (September 1996)

Power and Water Supply Department

Total Employee: 309
Office Staff 9
- Manager 1
- Chief Engineer 1
- Water Supply Engineer 1
- Electric Engineer 1
- Accounting and Finance 1
- Dispatcher 4
- District 1 Total 165
- District 2 Total 135

Power and Water Supply District No.1

District No.1 Total: 165
Office staff 13
- District Manager 1
- Chief Engineer 1
- Personnel Affairs 1
- Mechanical Engineer 1
- Labor Safety Engineer 1
- Water Supply Engineer 1
- Chief Accountant 1
- Senior Accountant 1
- Accountant 2
- Warehouse-man 1
- Typist/Cashier 1
- Economist 1

Sukhe-baatar Branch	12
Darkhan Branch	14
Zuunharaa Branch	21
Mandal Branch	10
Ulaan-baatar Central Branch	26
Amgalan, Honkhor Branch	10
Baga-nuur, Gagakhangai Branch	16
Electric Power Facility Repair Shop (Ulaan-baatar)	11
Water Supply Facility Repair Shop (Ulaan-baatar)	14
Repair Vehicle Garage (Ulaan-baatar)	15

Power and Water Supply District No.2

District No.2 Total: 135
Office staff 13
- District Manager 1
- Chief Engineer 1
- Deputy District Manager 1
- Electric Engineer 1
- Labor Safety Engineer 1
- Mechanical Engineer 1
- Personnel Affairs 1
- Chief Accountant 1
- Senior Accountant 1
- Accountant 1
- Typist 1
- Economist 1
- Warehouse/Cashier 1

Choir Branch	21
Airag Branch	10
Sain-shand Generator Branch	27
Ulaan-uul Branch	5
Zamyn-uud Generator Branch	29
Repair Vehicle Garage (Sain-shand)	13
Water Tanker Train (Sain-shand)	5
Electric Repair Team (Sain-shand)	5
Water Supply Repair Team (Sain-shand)	7

notes:
Mechanical Engineer: Responsible for investigate power and water consumption.
* Mechanical Engineer for District No.1 is assigned at Ulaan-baatra Central Branch

Chapter 11

APPENDIX

Appendix 11.1.1 Labor Cost and Equipment Cost

1) Labor at Site

No.	Manpower Description	Unit Rate/Month		Remarks
1	Foreman	10.02	US$/day	
2	Electrician	15.00	US$/day	
3	Driver	10.75	US$/day	
4	Mason	8.55	US$/day	
5	Carpenter	7.34	US$/day	
6	Operator	18.00	US$/day	
7	Skilled Labor	8.55	US$/day	
8	Welder	8.55	US$/day	
9	Unskilled Labor	7.34	US$/day	Unskilled Labor
10	Bridge specialist	73,400.00	Yen/day	Expatriate
11	Conc. repair specialist	73,400.00	Yen/day	Expatriate

Note; Based on inspection results.

2) Construction Equipment

No.	Equipment Description	urly/Monthly Rate		Capacity
1	Bulldozer	572.83	US$/day	21 ton
2	Macadam Roller	365.25	US$/day	10 ~ 12 ton
3	Grader	365.25	US$/day	3.1m
4	Truck Mixer	280.64	US$/day	4.0 cu.m
5	Dump Track	224.33	US$/day	11 ton
6	Compressor	162.84	US$/day	10.6cu.m/min.
7	Crane	488.41	US$/day	15ton
8	Jack Hammer	203.56	US$/day	1300kg Giant Breaker
9	Generator Set	221.46	US$/day	150 KVA
10	Back hoe	290.04	US$/day	0.6 cu.m
11	Batching Plant	616.87	US$/day	0.5 cu.m
12	Aggregate Crusher	1,500.00	US$/day	30 ton/hr
13	Loader	368.74	US$/day	2.1 cu.m
14	Welding Machine	20.00	US$/day	250 A

Note: Based on market price, when available.

Appendix 11-2-1

Evaluation of Existing Embankment

No.	Location	Section Length(m)	Situation: River Condition	Situation: Revetment by MR	Situation: Erosion m / year	Evaluation Results: Evaluation of Safety	Evaluation Results: Evaluation of Durabilty	Evaluation Results: Total Score	Evaluation Results: Construction Stage
			a.	b.	c.	d.	e.	f.	g.
1	11 pk 1 - 4	250	4	4	1	100	100	200	1
2	16 pk 1 - 4	380	4	1	1	70	80	150	2
3	31 pk 2 - 4	120	4	4	1	100	80	180	1
4	51 - 52 km	200	3	2	3	80	100	180	1
5	54 pk 4 - 5	100	3	1	2	70	100	170	1
6	55 pk 9	80	3	1	1	70	70	140	3
7	57 pk 9	160	3	1	2	80	80	160	1
8	65 pk 7	120	4	1	2	70	80	150	2
9	67 pk 4 - 6	280	4	2	4	100	80	180	1
10	88 pk 4 - 10	90	3	1	3	70	70	140	3
11	208 pk 1 - 2		3	4	3	100	80	180	1

Note :

		Symbol
a. River condition		
	: Highly unstable stream	4
	: Unstable stream	3
b. Rip rap construction		
	: Equal or more than 1,000 cu.m rip rap was placed.	4
	: Equal or more than 500 cu.m but less than 1,000 cu.m rip rap was placed.	3
	: Less than 500 cu.m rip rap was placed.	2
	: No rip rap was placed.	1
c. Erosion		
	: Erosion 3 - 5 m / year	4
	: Erosion 2 - 4 m / year	3
	: Erosion 1 - 3 m / year	2
	: Erosion in the past but no erosion is observed so far.	1

d. Synthetic evaluation of safety by score / Based on determination of Item a. b. c. evaluated by visual site inspection results

Description		Score
Very poor	:	100
Poor	:	80
Not so poor	:	70

e. Evaluation of durability / Made by visual site inspection results

Description		Score
Very poor	:	100
Poor	:	80
Not so poor	:	70

f.g. Total Score and Construction Stage

Score	Stage
160 <= Score	1
150 <= Score < 160	2
Score < 150	3

Appendix 11-2-2 Evaluation of Nature of Bridge Problems

		No.	Weight	1	2	3	4	5	6	7	8	9	10	11	12
		Location		235pk3	245pk5	255pk3	255pk8	285pk1	289pk1	326pk9	334pk3	338pk10	342pk2	344pk1	356pk2
		Span arrangement		2@9.3m	2@9.3m	2@7.3m	1@7.3m	1@9.3m	1@11.5m	3@11.5m	2@11.5m	1@7.3m	1@7.3m	1@7.3m	2@7.3m
Evaluation	Superstructure	Main Girder	10	1	1	1	1	2	1	2	4	4	1	1	4
				10	10	10	10	20	10	20	40	40	10	10	40
of Safety		Conc. Slab, etc.	5	3	3	3	1	3	3	3	3	3	2	4	3
				15	15	15	5	15	15	15	15	15	10	20	15
Condition	Substructure	Cracks, deterioration, defects	10	1	1	1	2	1	1	1	1	1	2	1	1
				10	10	10	20	10	10	10	10	10	20	10	10
Durability	Expected danger		15	2	2	4	1	2	4	2	2	4	2	4	4
				30	30	60	15	30	60	30	30	60	30	60	60
	Total Score			65	65	95	50	75	95	75	95	125	70	100	125
	Evaluation of Structure					Poor			Poor		Poor	Poor		Poor	
Serviceability	Vertical clearance for drainage and passage			3	3	1	1	1	1	1	3	3	3	1	1
Synthetic Judgment				RPR	RPR	RPC	RPR	RPR	RPC	RPR	RPC	RPC	RPR	RPC	RPC
Priority				1	1	1	4	1	1	1	1	1	1	1	1

Note:

RPR : Repair by resign injection .

RPC : Replace with new concrete bridge

Evaluation of Structure

Score >= 95 Heavily deteriorated and/or structurally damaged.

Score < 95 Deteriorated but not serious so far.

Priority and Construction Stage

Score >= 95 Priority 1 : Construction Stage 1

95 >Score>= 65 Priority 2 : Construction Stage 1

65 >Score Priority 4 : Construction Stage 3

a **Evaluation of safety condition**

		Score
Ranking A	Structurally inadequate major defects	4
Ranking B	Not structural but extensive defects.	3
Ranking C	Moderate defects	2
Ranking D	Light/minor defects	1

b **Evaluation of durability**

Expected danger is:

Very near future	4
Near future	2
Not near future	1

c **Serviceability**

Poor	: Vertical clearance is less than 2.0 meter.	3
Fair	: Vertical clearance is equal or more than 2.0 meter.	1

Appendix. 11-2-3 **Evaluation of Capacity of Drainage Facility**

TYPE	Location	Dimensions of Existing l (m)	b (m)	h (m)	H2/3 (m)	Q (cu.m/sec)	H/h	Estimated Q1% (cu.m/sec)	Q0.33% (cu.m/sec)	Shortage dQ1% (cu.m/sec)	dQ0.33% (cu.m/sec)	Qreq. Q0.33 *1.2	Design Bridge Wreq.(m)	Culvert Wreq.(m)	Evaluation Score *1 Capa. 15	CVT H 10	BR. span 5	Inspec'n 15	Note	Total	Priority
BR	11 pk 8	4.00	3.00		2.20	13.82		15.90	19.90	2.08	6.08	7.30		2.0*1	1		4	2		65	3
BR	14 pk 1	3.80	3.00		1.44	7.30		11.40	14.30	4.10	7.00	8.40		2.0*1	1		4	2		65	3
BR	20 pk 2	4.00	4.00		2.28	19.49		26.60	33.30	7.11	13.81	16.57		2.5*1	3		4	2		95	2
CT	21 pk 6	19.80	2.00	1.30	2.88	13.30	2.22	17.30	21.60	4.00	8.30	9.96		2.0*1	1	4		2		85	2
CT	22 pk 8	18.20	1.50	1.60	2.16	8.20	1.35	11.70	14.60	3.50	6.40	7.68		2.0*1	1	3		2		75	3
PCT	22 pk 10	16.00		2.00	3.44	9.90	1.72	17.20	21.50	7.30	11.60	13.92		2.0*1	2	2		3		95	2
BR	34 pk 3	4.00	2.00		3.45	18.16		19.70	24.60	1.54	6.44	7.73		2.0*1	1		4			35	4
BR	37 pk 7	4.00	4.00		2.30	19.75		23.00	28.80	3.25	9.05	10.86		2.0*1	2		4	1		65	3
BR	41 pk 2	4.10	3.00		1.93	11.70		13.30	16.60	1.60	4.90	5.88		2.0*1	1		4			35	4
BR	50 pk 5	4.00	3.00		1.75	9.90		14.80	18.50	4.90	8.60	10.32		2.0*1	2		4	1		65	3
BR	51 pk 3	4.00	2.00		1.28	4.20		4.80	6.00	0.60	1.80	2.16		2.0*1	1		4			35	4
BR	54 pk 10	4.40	3.00		1.42	7.25		11.70	14.60	4.45	7.35	8.82		2.0*1	1		4	2		65	3
BR	56 pk 1	4.40	2.00		1.90	7.80		9.65	12.10	1.85	4.30	5.16		2.0*1	1		4			35	4
BR	56 pk 8	4.80	4.00		2.25	19.35		23.70	29.60	4.35	10.25	12.30		2.0*1	2		4	1		65	3
BR	57 pk 10	4.50	2.00		2.02	8.20		8.20	10.30	0.00	2.10	2.52		2.0*1	1		4			35	4
BR	59 pk 9	4.00	4.00		2.10	17.30		23.10	28.90	5.80	11.60	13.92		2.0*1	2		4	1		65	3
BR	82 pk 6	4.10	2.00		2.26	10.10		10.20	12.80	0.10	2.70	3.24		2.0*1	1		4			35	4
BR	88 pk 6	6.80	2.00		1.35	4.55		5.10	6.40	0.55	1.85	2.22		2.0*1	1		2			25	4
BR	88 pk 9	10.00			1.97	1.98		4.80	6.00	2.82	4.02	4.82		2.0*1	2			4	1/	90	2
BR	89 pk 7	4.10	3.00		1.92	11.70		18.70	23.40	7.00	11.70	14.04		2.5*1	2		4	4		110	1
BR	93 pk 1	4.00	2.00		1.63	5.80		8.90	11.10	3.10	5.30						4			20	4
BR	95 pk 2	3.80	2.00		1.42	5.00		9.60	12.00	4.60	7.00	8.40		2.0*1	1		4	2		65	3
PCT	97 pk 5	10.00		1.00	0.80	0.72	0.80	19.10	23.90	18.38	23.18	27.82		2.0*2	4	4		4		160	1
BR	100 pk 7	4.10	2.00		1.29	4.20		17.10	21.40	12.90	17.20	20.64		2.5*1	3		4	3		110	1
BR	107 pk 6	4.10	2.00		1.81	7.25		8.10	10.10	0.85	2.85	3.42		2.0*1	1		4			35	4
BR	111 pk 9	3.80	4.00		1.75	13.10		18.10	22.60	5.00	9.50	11.40		2.0*1	2		4	1		65	3
BR	113 pk 4	3.80	2.00		1.82	7.25		10.40	13.00	3.15	5.75	6.90		2.0*1	1		4	2		65	3
BR	116 pk 6	4.00	2.00		1.25	4.20		12.50	15.60	8.30	11.40	13.68		2.0*1	2		4	3		95	2
CT	123 pk 1	9.00	3.00	1.20	1.90	13.00	1.58	13.50	16.90	0.50	3.90	4.68		2.0*1	1	4				55	4
CT	125 pk 8	9.80	5.00	1.35	1.95	23.10	1.44	37.40	46.80	14.30	23.70	28.44		2.5*2	4	4		4		160	1
CT	125 pk 8	9.80	2.50	1.95	2.55	17.70	1.31	37.40	46.80	19.70	29.10	34.92		2.5*2	4	3		4		150	1
CT	125 pk 8	6.00	2.00	1.25	1.48	6.26	1.18	37.40	46.80	31.14	40.54	48.65	10.0*1		4	4		4		160	1
CT	128 pk 7	91.00	2.20	1.25	1.50	6.89	1.20	10.50	13.10	3.61	6.21	7.45		2.0*1	1	4		1		70	3
CT	132 pk 6	10.00	2.00	1.92	1.58	5.66	0.82	6.50	8.10	0.84	2.44	2.93		2.0*1	1	3				45	4
BR	135 pk 3	4.10	2.00		1.70	6.60		1.66	2.10	-4.94	-4.50	-5.40					4			20	4
BR	136 pk 8	3.80	2.00		0.90	2.25		4.47	5.60	2.22	3.35	4.02		2.0*1	1		4	1		50	3
BR	138 pk 6	4.10	2.00		1.20	3.60		10.50	13.10	6.90	9.50	11.40		2.0*1	2		4	3		95	2

TYPE	Location	Dimensions of Existing. l (m)	b (m)	h (m)	H2/3 (m)	Q (cu.m/sec)	H/h	Estimated Q1% (cu.m/sec)	Q0.33% (cu.m/sec)	Shortage dQ1% (cu.m/sec)	dQ0.33% (cu.m/sec)	Qreq. Q0.33 *1.2	Design Bridge Wreq.(m)	Culvert Wreq.(m)	Evaluation Score *1 Capa. 15	CVT H 10	BR. span 5	Inspec'n 15	Note	Total	Priority
CT	141 pk 6	13.70	1.50	1.90	2.41	9.77	1.27	11.80	14.80	2.03	5.03	6.04		2.0*1	2	3		1		75	3
BR	145 pk 1	3.80	2.00		2.13	8.80		29.70	37.10	20.90	28.30	33.96		2.5*2	4		4	4		140	2
BR	151 pk 3	3.80	4.00		1.59	12.00		14.40	18.00	2.40	6.00	7.20		2.0*1	1		4	2		65	3
BR	155 pk 5	3.80	2.00		1.22	3.60		6.40	8.00	2.80	4.40	5.28		2.0*1	1		4	2		65	3
CT	157 pk 5	13.10	1.70	1.70	2.20	7.60	1.29	7.92	9.90	0.32	2.30	2.76		2.0*1	1	3				45	4
BR	158 pk 9	4.10	2.00		1.48	5.55		9.80	12.30	4.25	6.75						4	3		65	3
CT	160 pk 9	8.00		1.25	1.38	2.12	1.10	5.90	7.40	3.78	5.28	6.34		2.0*1	1	4		1		70	3
CT	166 pk 2	18.80	2.00	2.20	3.46	21.30	1.57	22.30	27.90	1.00	6.60	7.92		2.0*1	1	2		2		65	3
CT	170 pk 8	11.00		3.11	1.54	4.64	0.50	8.50	10.60	3.86	5.96	7.15		2.0*1	1	1		3		70	3
BR	171 pk 5	4.10	3.00		1.36	7.25		8.02	10.00	0.77	2.75	3.30		2.0*1	1		4			35	4
BR	172 pk 10	4.10	3.00		2.37	11.70		19.00	23.80	7.30	12.10	14.52		2.5*1	2		4	3		95	2
BR	176 pk 6	4.10	3.00		1.61	9.00		12.30	15.40	3.30	6.40	7.68		2.0*1	1		4	2		65	3
CT	177 pk 6	5.30	1.00	1.00	1.70	3.54	1.70	4.40	5.50	0.86	1.96	2.35		2.0*1	1	4		1		70	3
BR	178 pk 7	3.80	3.00		1.86	11.20		14.00	17.50	2.80	6.30	7.56		2.0*1	1		4	2		65	3
CT	182 pk 3	5.50	1.00	1.40	1.87	4.42	1.34	5.04	6.30	0.62	1.88	2.26		2.0*1	1	4		1		70	3
BR	185 pk 6	4.10	3.00		1.95	12.40		15.50	19.40	3.10	7.00	8.40		2.0*1	1		4	2		65	3
BR	189 pk 7	3.80	3.00		2.46	15.90		17.90	22.40	2.00	6.50	7.80		2.0*1	1		4	2		65	3
BR	191 pk 5	4.10	4.00		1.78	13.10		14.40	18.00	1.30	4.90	5.88		2.0*1	1		4			35	4
CT	197 pk 9	6.00	1.00	1.50	1.70	3.75	1.13	18.00	25.20	14.25	21.45	25.74		2.0*2	4	3		4		150	1
CT	205 pk 7	8.20		1.00	1.87	1.87	1.87	3.59	4.50	1.72	2.63	3.16		2.0*1	1	4		1		70	3
CT	207 pk 2	11.40	1.00	1.20	3.10	6.65	2.58	8.30	10.40	1.65	3.75	4.50		2.0*1	1	4		1		70	3
CT	207 pk 8	10.00		1.00	2.54	2.55	2.54	3.13	3.90	0.58	1.35					4				40	4
BR	211 pk 1	4.10	3.00		1.55	8.75		13.10	16.40	4.35	7.65	9.18		2.0*1	1		4	2		65	3
BR	212 pk 8	4.10	3.00		1.70	9.90		12.70	15.90	2.80	6.00	7.20		2.0*1	1		4	2		65	3
BR	216 pk 6	4.10	8.00		2.39	43.80		46.80	58.50	3.00	14.70	17.64		2.5*1	3			3		90	2
CT	217 pk 9	8.00		1.00	2.00	1.98	2.00	8.46	10.60	6.48	8.62	10.34		2.0*1	1	4		1	2/	70	3
BR	222 pk 10	3.80	1.75		1.30	4.30		6.00	7.50	1.70	3.20	3.84		2.0*1	1		4			35	4
BR	225 pk 8	3.80	2.00		2.15	8.80		9.50	11.90	0.70	3.10	3.72		2.0*1	1		4			35	4
BR	228 pk 6	3.80	2.00		1.90	7.80		8.70	10.90	0.90	3.10	3.72		2.0*1	1		4			35	4
CT	230 pk 9	15.00	2.50	2.65	2.96	21.40	1.12	40.50	50.60	19.10	29.20	35.04		2.5*2	4	1		4		130	1
BR	235 pk 3	3.80	14.50		1.65	52.50		77.10	96.40	24.60	43.90	52.68	10.0*1		4			4		120	1
BR	236 pk 8	3.80	3.00		2.36	14.70		16.60	20.80	1.90	6.10	7.32		2.0*1	1		4	2		65	3
BR	238 pk 4	3.80	2.00		1.35	4.50		5.85	7.30	1.35	2.80	3.36		2.0*1	1		4			35	4
BR	239 pk 9	3.80	2.00		1.76	6.80		8.57	10.70	1.77	3.90	4.68		2.0*1	1		4			35	4
BR	242 pk 4	3.80	3.00		1.45	7.20		23.40	29.30	16.20	22.10	26.52		2.0*2	4		4	4		140	1
BR	243 pk 10	3.80	2.00		1.45	5.00		10.50	13.10	5.50	8.10	9.72		2.0*1	1		4	2		65	3
BR	244 pk 7	3.80	2.00		1.56	5.57		7.85	9.80	2.28	4.23	5.08		2.0*1	1		4	2		65	3
BR	252 pk 1	3.80	3.00		1.77	9.40		8.75	10.90	-0.65	1.50	1.80			1		4			35	4
CT	253 pk 3	14.00	3.00	1.50	1.79	11.70	1.19	24.50	30.60	12.80	18.90	22.68		2.0*2	3	3		4		135	1

TYPE	Location	Dimensions of Existing						Estimated		Shortage		Qreq.	Design		Evaluation Score *1				Note	Total	Priority
		l	b	h	H2/3	Q	H/h	Q1%	Q0.33%	dQ1%	dQ0.33%	Q0.33	Bridge	Culvert	Capa.	CVT H	BR. span	Inspec'n			
		(m)	(m)	(m)	(m)	(cu.m/sec)		(cu.m/sec)	(cu.m/sec)	(cu.m/sec)	(cu.m/sec)	*1.2	Wreq.(m)	Wreq.(m)	15	10	5	15			
BR	255 pk 3	3.80	10.50		2.35	64.60		84.40	105.00	19.80	40.40	48.48	10.0*1		4			3		105	1
CT	261 pk 1	11.00		1.25	1.81	2.38	1.45	2.80	3.50	0.42	1.12	1.34		2.0*1	1	4				55	4
BR	261 pk 6	3.80	3.70		1.90	14.80		18.30	22.90	3.50	8.10	9.72		2.0*1	1		4	2		65	3
BR	268 pk 3	3.80	3.00		1.45	7.20		19.40	24.30	12.20	17.10	20.52		2.5*1	3			3		90	1
BR	270 pk 1	3.80	4.00		1.83	14.40		17.40	21.80	3.00	7.40	8.88		2.0*1	1		4	2		65	3
CT	273 pk 1	12.50	1.00	1.15	2.15	4.69	1.87	14.00	17.50	9.31	12.81	15.37		2.5*1	1	4		1	1/	70	3
BR	276 pk 8	3.80	2.00		1.46	5.00		7.97	10.00	2.97	5.00	6.00		2.0*1	1		4	2		65	3
BR	277 pk 8	3.80	2.00		1.55	5.50		9.36	11.70	3.86	6.20	7.44		2.0*1	1		4	2		65	3
BR	279 pk 3	3.80	3.00		1.87	10.60		12.70	15.90	2.10	5.30	6.36		2.0*1	1		4	2		65	3
CT	280 pk 5	9.00		1.50	1.67	3.27	1.11	9.30	11.60	6.03	8.33	10.00		2.0*1	1	3		2	1/	75	3
CT	280 pk 10	9.00	1.50	2.10	2.12	2.12	1.01	7.20	9.00	5.08	6.88					2				20	4
CT	282 pk 6	9.00	9.00	1.50	2.40	5.37	1.60	9.03	11.30	3.66	5.93	7.12		2.0*1	1	3		3		90	2
CT	289 pk 7	8.00		1.25	1.44	2.26	1.15	2.50	3.10	0.24	0.84					4				40	4
CT	307 pk 3	14.00	1.5*2	1.60	2.17	10.60	1.36	15.10	18.90	4.50	8.30	9.96		2.0*1	1	3		2	1/	75	3
BR	311 pk 8	3.80	4.00		1.63	11.60		20.60	25.80	9.00	14.20	17.04		2.5*1	2		4	1	1/	65	3
CT	313 pk 10	8.00	1.40	1.75	2.01	6.92	1.15	9.28	11.60	2.36	4.68	5.62		2.0*1	1	3		4		105	1
CT	314 pk 10	42.00	3.00	0.50	0.65	2.61	1.30	19.10	23.90	16.49	21.29	25.55		2.0*2	4	4		4		160	1
CT	319 pk 2	8.00		1.25	1.59	2.42	1.27	5.60	7.00	3.18	4.58	5.50		2.0*1	1	4		2		85	2
CT	319 pk 2	9.00		1.00	2.08	2.02	2.08	5.22	6.50	3.20	4.48	5.38		2.0*1	1	4		1		70	3
CT	323 pk 5	13.00	1.50	1.80	2.78	11.30	1.54	16.70	20.90	5.40	9.60	11.52		2.0*1	2	3		2		90	2
CT	324 pk 5	8.00		1.25	1.55	2.38	1.24	4.02	5.00	1.64	2.62	3.14		2.0*1	1	4				55	4
BR	331 pk 7	3.80	2.00		2.16	8.90		12.60	15.80	3.70	6.90	8.28		2.0*1	1		4	2		65	3
CT	332 pk 4	7.50	1.50	3.10	1.97	3.79	0.64	11.00	13.80	7.21	10.01	12.01		2.0*1	2	1		3		85	2
BR	333 pk 5	3.80	2.00		2.00	8.07		12.50	15.60	4.43	7.53	9.04		2.0*1	1		4	2		65	3
BR	334 pk 4	3.80	20.00		1.40	57.90		77.90	97.40	20.00	39.50	47.40	10.0*1		4			3		105	1
BR	342 pk 2	3.80	4.00		1.68	12.00		19.20	24.00	7.20	12.00	14.40		2.5*1	2		4	3		95	2
CT	345 pk 7	13.00	3.00	1.80	2.04	13.80	1.13	22.50	28.10	8.70	14.30	17.16		2.5*1	3	3		1		90	2
BR	348 pk 7	7.00	2.00		2.00	8.07		20.70	25.90	12.63	17.83	21.40		2.5*1	3		4	2		95	2
BR	349 pk 10	3.80	8.00		1.85	29.90		40.50	50.60	10.60	20.70	24.84		2.0*2	3			3		90	2
BR	352 pk 7	3.80	12.00		2.00	58.00		90.50	113.00	32.50	55.00	66.00	12.0*1		4			4		120	1
BR	356 pk 1	3.80	12.00		2.00	58.00		72.00	90.00	14.00	32.00	38.40	10.0*1		4			4		120	1
CT	357 pk 7	8.50	1.00	1.50	2.04	4.84	1.36	7.90	9.90	3.06	5.06	6.07		2.0*1	1	3		3		90	2
BR	365 pk 3	3.80	4.00		2.05	16.30		21.60	27.00	5.30	10.70	12.84		2.0*1	2		4	3		95	2
BR	367 pk 5	3.80	2.00		1.10	3.38		5.18	6.50	1.80	3.12				1		4			35	4
BR	370 pk 9	3.80	2.00		1.45	4.90		9.83	12.30	4.93	7.40	8.88		2.0*1	1		4	2		65	3
CT	378 pk 3	32.00	1.00	2.40	4.89	15.30	2.04	7.42	9.30	-7.88	-6.00					2		3		65	3
CT	381 pk 4	9.00		1.00	1.07	1.09	1.07	1.33	1.70	0.24	0.61	0.73		2.0*1	1	4				55	4
BR	386 pk 8	3.80	7.50		2.25	43.00		38.60	48.30	-4.40	5.30	6.36		2.0*1	1		4			35	4
BR	389 pk 1	4.50	6.00		2.00	24.20		44.00	55.00	19.80	30.80	36.96		2.5*2	4			4		120	1

TYPE	Location	Dimensions of Existing.						Estimated		Shortage		Qreq.	Design		Evaluation Score *1				Note	Total	Priority
		l	b	h	H2/3	Q	H/h	Q1%	Q0.33%	dQ1%	dQ0.33%	Q0.33	Bridge	Culvert	Capa.	CVT H	BR. span	Inspec'n			
		(m)	(m)	(m)	(m)	(cu.m/sec)		(cu.m/sec)	(cu.m/sec)	(cu.m/sec)	(cu.m/sec)	*1.2	Wreq.(m)	Wreq.(m)	15	10	5	15			
BR	391 pk 4	3.80	6.00		3.00	44.30		51.50	64.40	7.20	20.10	24.12		2.0*2	3			4		105	1
BR	394 pk 4	25.00	4.00		1.25	7.60		36.50	45.60	28.90	38.00	45.60	10.0*1		4		4	4		140	1

Note:

- l : Length of drainage facility
- b : Clear span or clear spacing of drainage facility
- h : Clear height of drainage facility
- H2/3 : Critical depth of a stream
- Q0.33 : 1/300 proberbility flood discharge volume
- : Required capacity
- : Evaluation of clear height of a culvert
- : Evaluation of clear span of a bridge
- : Evaluation of visual site inspection results.

*1

Capa : **Shortage of capacity**

			Score
	Qshort >=	25	4
15	<=Qshort<	25	3
10	<=Qshort<	15	2
10	<Qshort		1

CVT H: **Clearance of Culvert**

	H >=	2.5	1
2	<=H<	2.5	2
1.5	<=H<	2	3
1.5	<H		4

BR. SpaBridge span

L>=	5	2
L<	5	4

Inspect Inspection

Dangers	4
Damaged	3
Little Damage	2
No damage	1

Priority and Construction Stage

Score>=	105	Priority Stage 1
## >Score>=	85	Priority Stage 2
85 >Score>=	65	Priority Stage 3
65 >Score		Priority Stage 3

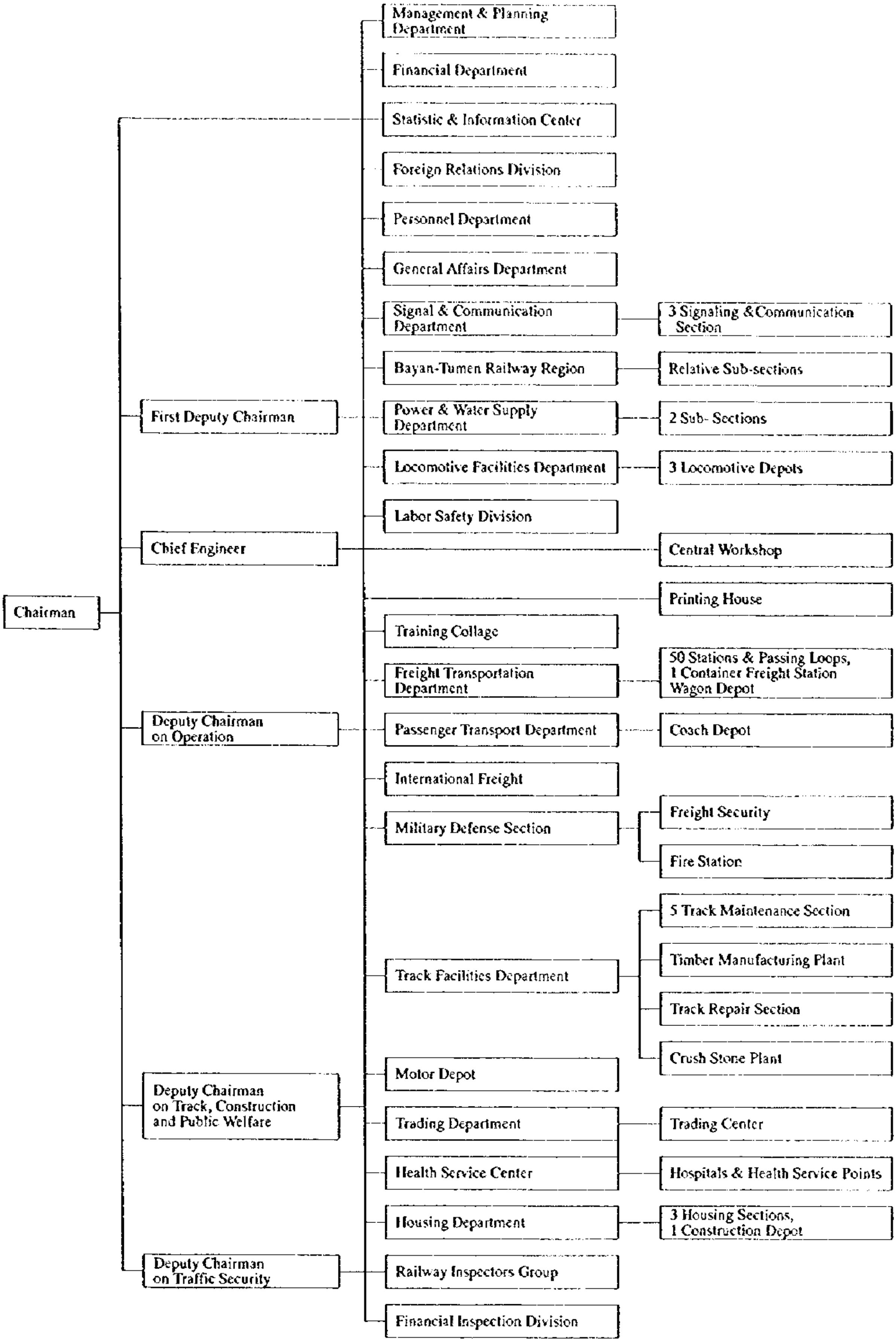
Remarks

1/ Design flood discharge volume is revised based on site inspection and past records.

2/ Design flood discharge volume is revised due to new drainage facility construction.

Chapter 12

APPENDIX



APPENDIX 12 – 1 Mongolian Railway Organization Chart

Appendix 12-2 Number of Employees, Mongolian Railway (1991 – 1996)

SECTION	1991			1992			1993			1994			1995			1996			'96 LESS '91
	RAIL.	OTHERS	TOTAL	RAIL.	OTHERS	TOTAL	RAIL.	OTHERS	TOTAL	RAIL.	OTHERS	TOTAL	RAIL.	OTHERS	TOTAL	RAIL.	OTHERS	TOTAL	
HEADQUARTERS	183	13	196	166	11	177	162	13	175	171	8	179	167	6	173	163	4	167	-29
FREIGHT TRANSPORTATION	1,277	371	1,648	1,232	345	1,577	1,205	372	1,577	1,540	384	1,924	1,570	351	1,921	1,585	142	1,727	79
PASSENGER TRANSPORTATION	1,295	164	1,459	1,230	165	1,395	1,215	164	1,379	856	222	1,078	883	225	1,108	945	349	1,234	-165
LOCOMOTIVE FACILITIES	1,351	195	1,546	1,176	162	1,338	1,196	144	1,340	1,154	151	1,305	1,193	122	1,315	1,224	149	1,373	-173
TRACK FACILITIES	1,856	1,336	3,192	1,816	1,199	3,015	1,859	1,079	2,938	1,873	1,085	2,958	1,858	1,136	2,994	1,864	1,139	3,003	-189
SIGNAL AND COMMUNICATION	561	63	624	555	61	616	541	69	610	517	59	576	511	66	577	510	69	579	-45
BAYAN-TUMEN RAILWAY DIV.	326	340	666	300	293	593	291	204	495	283	191	474	269	160	429	234	130	364	-302
SECURITY	174	148	322	179	108	287	185	120	305	187	131	318	185	173	358	184	187	371	43
POWER SUPPLY		331	331		297	297		295	295		296	296		307	307		309	309	-22
HOUSING CONSTRUCTION		1,883	1,883		1,616	1,616		1,568	1,568		1,551	1,551		1,541	1,541		1,499	1,499	-384
TRADE SALES		942	942		811	811		694	694		594	594		592	592		483	483	-459
CLINIC		752	752		725	725		690	690		655	655		619	619		599	599	-153
NURSERY		494	494		510	510		486	486		485	485		470	470		469	469	-25
COLLEGE		221	221		191	191		154	154		148	148		145	145		138	138	-83
REST HOUSE		15	15		109	109		87	87		78	78		79	79		81	81	66
OTHERS		639	639		523	523		417	417		390	390		369	369		493	493	-146
TOTAL	7,023	7,907	14,930	6,654	7,126	13,780	6,654	6,556	13,210	6,581	6,428	13,009	6,636	6,361	12,997	6,709	6,240	12,949	-1,981
INDEX	100	100	100	95	90	92	95	83	88	94	81	87	94	80	87	96	79	87	
TRANSPORTATIN VOLUME																			
FREIGHT																			
MILLION TON			10.2			8.5			7.8			7.1			7.3			7.5	-2.7
INDEX			100			83			76			70			72			74	
MILLION TON-KM			3,013			2,763			2,527			2,150			2,284			2,540	-473
INDEX			100			92			84			71			76			84	
PASSENGER																			
MILLION PASSENGERS			2.5			2.5			2.2			2.9			2.8			3.0	0.5
INDEX			100			100			88			116			112			120	
MILLION PASS.-KM			596			636			583			789			681			744	148
INDEX			100			107			98			132			114			125	
TOTAL																			
MILLION PASS./TON-KM			3,609			3,399			3,110			2,939			2,965			3,284	-325
INDEX			100			94			86			81			82			91	

(MONGOLIAN RAILWAY)

Appendix 12-3 Mongolian Railway Profit & Loss Statement

(Unit: Thousand Tugrik)

	1991	1992	1993	1994	1995	1996
RAILWAY DIVISION						
FREIGHT	375,564	647,114	7,171,333	8,875,533	10,741,397	14,993,674
PASSENGER	199,587	401,698	2,223,886	4,133,163	4,793,320	5,567,048
OTHERS	27,519	55,262	451,931	512,741	840,536	828,669
OPERATING INCOME	602,670	1,104,074	9,847,150	13,521,437	16,375,253	21,389,391
SALARIES AND WAGES	123,524	200,544	801,630	1,591,236	2,698,713	3,462,680
FUEL	78,089	255,935	3,195,555	4,260,646	5,146,221	4,839,295
MATERIALS	37,478	86,360	657,598	507,135	1,068,803	1,241,267
OTHER EXPENSES	201,755	430,158	4,086,876	5,669,214	5,762,454	10,612,183
(DEPRECIATION)	139,522	242,102	2,146,906	3,895,540	3,973,584	4,183,107
OPERATING EXPENSE	440,846	972,997	8,741,659	12,028,231	14,676,191	20,155,425
OPERATING PROFIT	161,824	131,077	1,105,491	1,493,206	1,699,062	1,233,966
OTHER DIVISIONS						
REVENUE	531,818	976,266	4,827,629	7,837,349	10,004,813	17,090,065
EXPENSE	612,214	1,063,811	5,672,681	8,699,730	11,003,352	17,552,057
LOSS	-80,396	-87,545	-845,052	-862,381	-998,539	-461,992
NET PROFIT	81,428	43,532	260,439	630,825	700,523	771,974
DIVIDEND PAID TO						
MONGOLIAN GOVERNMENT	8,000	15,592	30,000	100,000	150,000	175,000
RUSSIAN GOVERNMENT	19,052	15,592	30,000	100,000	150,000	175,000
TOTAL DIVIDEND	27,052	31,184	60,000	200,000	300,000	350,000
PROFIT AFTER DIVIDEND	54,376	12,348	200,439	430,825	400,523	421,974

Appendix 12-4 Mongolian Railway Revenues and Expenses 1996

(Unit: Million Tugrik)

CATEGORIES	REVENUES	EXPENSES	BALANCE
I TRANSPORT DIVISION	21,389.4	20,155.4	1,234.0
II INDUSTRIAL OUTPUT			
IDUS. PDT. SALE	1,038.5	1,198.5	-160.0
DISTR. OF INDUS. PDTS.	1,008.6	810.4	198.2
TOTAL II	2,047.1	2,008.9	38.2
III NON-OPERATIONAL ACTIV.			
SERVICES OF NON-OPER DEP.	1,830.6	941.0	889.6
DISTR. OF ABOVE SERVICES	2,250.8	1,741.4	509.4
TOTAL III	4,081.4	2,682.4	1,399.0
IV CAPITAL REPARIRS-SUBCONTR.	1,269.1	1,238.3	30.8
V CONSTR. WORK-SUBCONTR.	1,109.0	1,106.7	2.3
VI HOUSING SERVICES	154.4	645.0	-490.6
SOCIAL SERVICES	983.7	1,280.7	-297.0
TOTAL VI	1,138.1	1,925.7	-787.6
VII MATERIAL SUPPLY DIV.	6,704.3	6,628.3	76.0
TRADE SALES	359.9	352.4	7.5
TOTAL VII	7,064.2	6,980.7	83.5
VIII CLINIC	287.7	1,225.0	-937.3
RAILWAY COLLEGE	19.1	116.9	-97.8
CULTURAL ORGAN.	48.3	211.8	-163.5
TOTAL VIII	355.1	1,553.7	-1,198.6
IX FINES	5.2	0.3	4.9
EXPIRED CLAIMS		7.1	-7.1
WASTE LOSSES		0.2	-0.2
TRANSPORT LOSSES		7.0	-7.0
OTHERS	20.8	41.2	-20.4
TOTAL IX	26.0	55.8	-29.8
SUB-TOTAL-NON OPER.	17,090.0	17,552.2	-462.2
GRAND TOTAL	38,479.4	37,707.6	771.8

Outline of Freight Transportation Service Railways, Japan

1994

Railway	Commercial Distance: Passenger	Commercial Distance: Freight	Train km: Passenger	Train km: F&Mix	Train km: Total	Car km: Passenger	Car km: Freight	Car km: Total	Transportation Volume: Passenger. km	Transportation Volume: F. T. km	Transportation Volume: Total	Number of Employees	Empl. / Comm. km	Train km /Empl.	Car km /Empl.	Transpotation Volume / Employee
Major Railways	km	km	10^3km	10^3km	10^3km	10^3km	10^3km	10^3km	mil. P. km	mil. T. km	mil. P. T. km	Persons	Persons	10^3km	10^3km	10^3. P. T. km
Tobu Rw	463.3	113.1	35,305	216	35,521	239,553	1,935	241,488	14,366.1	31.3	14,397.3	7,601	16.4	4.67	31.8	1,894.1
Seibu Rw	176.6	68.2	18,919	88	19,007	150,935	717	151,652	9,489.0	14.5	9,503.5	3,949	22.4	4.81	38.4	2,406.6
Sagami Rw	32.8	6.7	4,773	3	4,776	45,773	13	45,786	2,822.7	0.4	2,823.1	1,180	36.0	4.05	38.8	2,392.4
Nagoya Rw	539.3	0.4	41,362	-	41,362	194,018	-	194,018	7,313.5	0.0	7,313.5	4,888	9.1	8.46	39.7	1,496.2
Sub T. /Av.	1,212.0	188.4	100,359	307	100,666	630,279	2,665	632,944	33,991.3	46.1	34,037.4	17,618	14.5	5.71	35.9	1,932.0
Local Railways	km	km	10^3km	10^3km	10^3km	10^3km	10^3km	10^3km	mil. P. km	mil. T. km	mil. P. T. km	Persons	Persons	10^3km	10^3km	10^3. P. T. km
KashimaRin	53.0	72.2	1,255	64	1,319	2,452	466	2,918	64.7	4.7	69.4	146	2.0	9.03	20.0	475.3
Kashima	27.2	19.5	507	15	522	542	55	597	10.1	1.1	11.2	51	1.9	10.24	11.7	218.7
Jyoushin	33.7	33.7	665	4	669	1,371	9	1,380	54.7	0.2	54.9	130	3.9	5.15	10.6	422.1
Chichibu	71.7	79.3	1,719	560	2,279	5,763	9,784	15,547	168.7	170.1	338.7	636	8.0	3.58	24.4	532.6
Gakunan	9.2	7.3	225	12	237	450	158	608	4.9	1.2	6.1	44	4.8	5.39	13.8	138.2
Ohigawa	65.0	62.7	666	92	758	1,749	85	1,834	30.6	0.5	31.1	109	1.7	6.95	16.8	285.1
Kamioka	19.9	16.9	135	12	147	135	12	147	1.2	1.3	2.5	19	1.0	7.74	7.7	130.1
Sanki	27.6	26.5	560	129	689	1,208	1,621	2,829	31.4	32.8	64.2	137	5.0	5.03	20.6	468.8
Kurobe	20.1	20.1	137	87	224	2,153	352	2,505	31.7	0.7	32.4	220	10.9	1.02	11.4	147.2
Tarumi	34.5	34.5	487	42	529	567	260	827	13.1	7.3	20.4	55	1.6	9.62	15.0	370.5
Heisei Tiku	49.2	9.8	1,177	15	1,192	1,314	144	1,458	28.5	5.5	33.9	75	1.5	15.89	19.4	452.3
Sub T. /Av.	411.1	382.5	7,533	1,032	8,565	17,704	12,946	30,650	439.4	225.3	664.7	1,622	3.7	5.28	18.9	409.8
Freight Railways	km	km	10^3km	10^3km	10^3km	10^3km	10^3km	10^3km	mil. P. km	mil. T. km	mil. P. T. km	Persons	Persons	10^3km	10^3km	10^3. P. T. km
TaiheiyouC	-	4.0	-	24	24	-	123	123	-	7.4	7.4	33	8.3	0.73	3.7	223.3
Kushiro D.	-	1.7	-	3	3	-	14	14	-	0.2	0.2	10	5.9	0.30	1.4	24.6
Tomakomai	-	10.2	-	7	7	-	98	98	-	2.0	2.0	28	2.7	0.25	3.5	70.1
Hatinohe Ri	-	8.5	-	15	15	-	108	108	-	2.0	2.0	55	6.5	0.27	2.0	37.0
Iwate Dev.	-	11.5	-	172	172	-	3,094	3,094	-	52.6	52.6	64	5.6	2.69	48.3	821.8
Sendai Rin.	-	9.5	-	46	46	-	421	421	-	8.0	8.0	150	15.8	0.31	2.8	53.1
Fukushima	-	6.6	-	17	17	-	168	168	-	2.7	2.7	67	10.2	0.25	2.5	39.6
Kosaka Sei	-	22.3	55	25	80	55	288	343	0.8	5.9	6.7	15	0.7	5.33	22.9	447.3
Akita Rin.	-	7.9	-	12	12	-	72	72	-	1.4	1.4	43	5.4	0.28	1.7	32.4
Niigata Rin	-	5.4	-	8	8	-	38	38	-	0.9	0.9	26	4.8	0.31	1.5	35.0
Echigo Ko.	-	7.6	-	13	13	-	13	13	-	0.3	0.3	8	1.1	1.63	1.6	32.7
Keiyou Rin	-	23.8	-	170	170	-	1,620	1,620	-	30.4	30.4	192	8.1	0.89	8.4	158.1
KanagawaR	-	16.3	-	147	147	-	480	480	-	7.8	7.8	316	19.4	0.47	1.5	24.8
Seinou Rw.	-	4.5	-	3	3	-	34	34	-	0.6	0.6	24	5.3	0.13	1.4	25.8
Nagoya Rin	-	20.5	-	71	71	-	1,010	1,010	-	13.5	13.5	138	6.7	0.51	7.3	97.8
Kinuura Rin	-	14.7	-	36	36	-	121	121	-	2.6	2.6	31	2.1	1.16	3.9	83.8
Mizusima R	10.4	16.5	272	42	314	577	587	1,164	16.6	6.5	23.1	69	4.2	4.55	16.9	334.3
Sub T. /Av.	10.4	191.5	327	811	1,138	632	8,289	8,921	17.4	144.7	162.1	1,269	6.6	0.90	7.0	127.7
Total Pri. R	7,081.9	827.9	502,141	2,150	504,291	2,766,983	23,914	2,790,897	152,028.0	416.1	152,444.1	105,066	-	4.80	26.6	1,450.9
JR Freight	-	10,043.7	-	83,678	83,678	-	1,297,023	1,297,023	-	24,077.4	24,077.4	9,398	0.9	8.90	138.0	2,562.0

Source : 1994 Railway Statistical Yearbook

Analytical Data of Operating Management Expenses (F. Year 1994) 1/2
(Major Railways, Metropolitan Subway, and Chichibu Railway)

Item / Company Name	Tobu Railway	Seibu Railway	Keisei Railway	Keio Railway	Tokyu Railway	Odakyu R. W.	KeikyuuR. W.	Sagami R. W.	Eidan Subway
Number of Employees (persons)	7, 601	3, 949	2, 350	2, 720	3, 741	3, 638	2, 866	1, 180	10, 460
Administrative Division (persons)	240	340	114	224	393	324	138	82	442
Ratio of Administration Division	3. 2%	8. 6%	4. 9%	8. 2%	10. 5%	8. 9%	4. 8%	7. 0%	4. 2%
Train km (1, 000 km)	35, 521	19, 007	11, 824	13, 419	14, 954	18, 447	13, 715	4, 775	27, 617
Car km (1, 000 km)	241, 704	151, 740	76, 737	105, 016	107, 562	132, 758	90, 617	45, 802	226, 906
Transportation Volume (million P. T. km)	14, 397	9, 503	3, 860	6, 936	8, 759	10, 982	6, 275	2, 823	15, 881
Operating Managment Expense (¥1, 000)									
Labor Cost	56, 135, 612	32, 919, 834	18, 985, 005	25, 381, 375	33, 324, 709	35, 410, 998	22, 400, 396	10, 395, 475	94, 212, 312
Material Cost									
Railway Maintenance Expense	4, 616, 907	4, 008, 638	2, 785, 203	1, 363, 131	8, 734, 387	5, 903, 977	3, 135, 611	994, 509	7, 866, 311
Cable Maintenance Expense	3, 575, 916	2, 304, 698	1, 182, 907	1, 629, 960	1, 812, 638	2, 524, 018	834, 071	428, 581	7, 098, 171
Car Maintenance Expense	5, 676, 193	4, 253, 628	1, 693, 741	2, 416, 712	3, 301, 386	2, 623, 167	1, 992, 574	539, 750	7, 157, 750
Operation Expense	7, 571, 356	5, 620, 000	2, 830, 819	4, 245, 259	3, 955, 063	4, 631, 705	3, 572, 285	1, 605, 520	7, 323, 854
Transportation Expense	8, 201, 113	1, 821, 830	3, 779, 485	1, 540, 592	7, 648, 500	3, 330, 783	1, 009, 490	756, 831	19, 490, 575
Maintenance & Management Expense	303, 761	507, 809	339, 929	1, 334, 462	967, 152	866, 679	714, 457	216, 616	2, 740, 661
Transportation Management Expense	3, 865, 147	441, 505	640, 899	1, 554, 958	617, 651	2, 294, 952	528, 393	18, 417	3, 338, 531
General Administrative Expense	1, 261, 372	733, 857	396, 979	1, 010, 317	2, 702, 154	2, 281, 985	936, 114	435, 024	2, 417, 014
Total Material Cost	35, 071, 765	19, 691, 965	13, 649, 962	15, 095, 391	29, 738, 931	24, 457, 266	12, 722, 995	4, 995, 248	57, 432, 867
Base Unit of Operating Management Expense									
Labor C. /No. of Employees (¥/Per.)	7, 385, 293	8, 336, 246	8, 078, 726	9, 331, 388	8, 907, 968	9, 733, 644	7, 815, 909	8, 809, 725	9, 006, 913
Base Unit Material Cost									
Railway M. Exp. /Car km (¥ / km)	19. 1	26. 4	36. 3	13. 0	81. 2	44. 5	34. 6	21. 7	34. 7
Cable M. Exp. /Car km (¥ / km)	100. 7	121. 3	100. 0	121. 5	121. 2	136. 8	60. 8	89. 8	257. 0
Car M. Exp. /Car km (¥ / km)	23. 5	28. 0	22. 1	23. 0	30. 7	19. 8	22. 0	11. 8	31. 5
Operating Exp. /Car km (¥ / km)	31. 3	37. 0	36. 9	40. 4	36. 8	34. 9	39. 4	35. 1	32. 3
Trans. Exp. /Trans. V. (¥/1000. P. T. km)	569. 6	191. 7	979. 2	222. 1	873. 2	303. 3	160. 9	268. 1	1, 227. 3
Maintenance Exp. /Car km (¥ / km)	1. 3	3. 3	4. 4	12. 7	9. 0	6. 5	7. 9	4. 7	12. 1
Trans. Exp. /Trans. V. (¥/1000. P. Tkm)	268. 5	46. 5	166. 0	224. 2	70. 5	209. 0	84. 2	6. 5	210. 2
General Admi. Exp/Emp. (¥ / Per)	165, 948. 2	185, 833. 6	168, 927. 2	371, 440. 1	722, 307. 9	627, 263. 6	326, 627. 4	368, 664. 4	231, 072. 1
Total Material Exp. /Car km (¥ / km)	145. 1	129. 8	177. 9	143. 7	276. 5	184. 2	140. 4	109. 1	253. 1

Analytical Data of Operating Management Expenses (F. Year 1994) 2/2
(Major Railways, Metropolitan Subway, and Chichibu Railway)

Item \ Company Name	Nagoya Railway	Kinnki-Nippon	Nankai R. W.	KeihanRailway	Hankyu R. W.	Hanshin R. W.	NishinihonRW	Ave. of 16 Co.	Chichibu RW
Number of Employees (persons)	4,888	11,373	3,468	3,041	4,232	1,333	1,078		636
Administrative Division (persons)	487	727	267	242	389	129	87		21
Ratio of Administration Division	10.0%	6.4%	7.7%	8.0%	9.2%	9.7%	8.1%	7.5%	3.3%
Train km (1,000 km)	41,362	69,633	16,960	15,217	21,675	7,284	10,043		2,279
Car km (1,000 km)	194,018	346,702	92,722	93,822	159,462	37,718	44,849		16,243
Transportation Volume (million P. T. km)	7,314	15,252	5,036	5,319	10,339	2,188	2,105		339
Operating Managment Expense (¥1,000)									
Labor Cost	31,030,974	82,352,951	26,565,890	26,063,051	44,193,096	9,840,752	8,943,316		4,796,651
Material Cost									
Railway Maintenance Expense	3,608,229	11,987,930	2,748,042	2,568,298	3,911,748	1,666,656	1,250,309		320,422
Cable Maintenance Expense	3,123,339	5,401,970	1,073,456	1,210,395	2,137,773	725,056	993,290		196,511
Car Maintenance Expense	7,179,603	6,375,029	1,600,769	1,558,787	3,369,816	898,970	997,322		79,132
Operation Expense	6,508,337	11,338,520	4,181,403	3,989,907	5,675,786	1,112,327	1,816,619		285,295
Transportation Expense	2,679,124	7,733,496	3,977,131	2,046,551	5,494,878	3,188,767	1,480,925		172,779
Maintenance & Management Expense	583,048	1,524,427	333,236	-	742,477	350,004	123,513		40,598
Transportation Management Expense	538,196	2,505,035	382,621	187,460	807,416	606,632	324,280		29,337
General Administrative Expense	2,174,975	2,752,869	1,041,127	1,632,892	2,958,927	758,700	364,727		113,562
Total Material Cost	26,394,851	49,619,276	15,337,785	13,194,290	25,098,821	9,307,112	7,350,985		1,237,636
Base Unit of Operating Management Expense									
Labor C. /No. of Employees (¥/Per.)	6,348,399	7,241,093	7,660,291	8,570,553	10,442,603	7,382,410	8,296,212	8,334,211	7,541,904
Base Unit Material Cost									
Railway M. Exp. /Car km (¥ / km)	18.6	34.6	29.6	27.4	24.5	44.2	27.9	32.4	19.7
Cable M. Exp. /Car km (¥ / km)	75.5	77.6	63.3	79.5	98.6	99.5	98.9	106.4	86.2
Car M. Exp. /Car km (¥ / km)	37.0	18.4	17.3	16.6	21.1	23.8	22.2	23.1	4.9
Operating Exp. /Car km (¥ / km)	33.5	32.7	45.1	42.5	35.6	29.5	40.5	36.5	17.6
Trans. Exp. /Trans. V. (¥/1000. P. T. km)	366.3	507.0	789.7	384.7	531.5	1,457.7	703.4	596.0	510.1
Maintenance Exp. /Car km (¥ / km)	3.0	4.4	3.6	0.0	4.7	9.3	2.8	5.6	2.5
Trans. Exp. /Trans. V. (¥/1000. P. Tkm)	73.6	164.2	76.0	35.2	78.1	277.3	154.0	134.0	86.6
General Admi. Exp/Emp. (¥ / Per)	444,962.2	242,053.0	300,209.6	536,958.9	699,179.3	569,167.3	338,336.7	393,684.5	178,556.6
Total Material Exp. /Car km (¥ / km)	136.0	143.1	165.4	140.6	157.4	246.8	163.9	169.6	76.2

Mongolian Railway Operating and Maintenance Expense Breakdown (1995)

(Unit : 1,000 Tugrik)

Expense Item	Labor Cost	Material Cost	Total Business Cost
Headquarters Overhead	92,503 (50.9%)	89,123 (49.1%)	181,626 (1.7%) (100.0%)
Freight Handling Fee	613,575 (36.5%)	1,067,084 (63.5%)	1,680,659 (15.7%) (100.0%)
Car Operation & Repair Expense	587,357 (10.8%)	4,862,483 (89.2%)	5,449,840 (50.9%) (100.0%)
Track Expense	713,485 (49.1%)	739,929 (50.9%)	1,453,414 (13.6%) (100.0%)
Signaling & Communication Expense	231,451 (50.6%)	226,224 (49.4%)	457,675 (4.3%) (100.0%)
Passenger Transportation Expense	314,532 (42.8%)	419,826 (57.2%)	734,358 (6.9%) (100.0%)
Military Security Expense	65,424 (56.0%)	51,332 (44.0%)	116,756 (1.1%) (100.0%)
Bayan-tumen Management Expense	80,386 (31.0%)	179,114 (69.0%)	259,500 (2.4%) (100.0%)
Track-Related Expense (to be paid to Russia)	0 (0.0%)	368,779 (100.0%)	368,779 (3.4%) (100.0%)
Total	2,698,713 (25.2%)	8,003,894 (74.8%)	10,702,607 (100.0%) (100.0%)

Appendix 12 - 8

Analytical Data of Operating Management Expense

Expense Item (Unit)	Mongolian Railway				Average of Major Private Railway Japan	Chichibu Railway
	Amount (Unit :1000 Tugrik)	Amount / Base Unit (Unit : Tugrik)	Inflation Factor (Unit :Tugrik)	Amount in Yen T. 1=¥5		
Labor Cost (Number of Employees)	2, 698, 713 6, 636 persons	406, 678 / person	560, 560	112. 1 (10^3yen)	8, 334. 2 (10^3yen)	7, 541. 9 (10^3yen)
Material Cost						
General Administration Expense (Number of Employees)	55, 156 6, 636 persons	8, 312 / person	11, 457	2. 3 (10^3yen)	393. 7 (10^3yen)	178. 6 (10^3yen)
Maintenance Management Expense (Car km)	19, 718 101. 3 million km	0. 19 / km	0. 27	0. 1 (yen)	5. 6 (yen)	2. 5 (yen)
Transpotation Management Cost (Person・ton・km)	14, 249 2, 965 million P. t. km	4. 81/10^3P. t. km	6. 62	1. 3 (yen)	134. 0 (yen)	86. 6 (yen)
Railway Maintenance Expense (Car km)	1, 126, 698 101. 3 million km	11. 13 / km	15. 33	3. 1 (yen)	32. 4 (yen)	19. 7 (yen)
Communication Maintenance Cost (Car km)	231, 724 4, 838 10^3 km	47. 90 / km	66. 02	13. 2 (yen)	106. 4 (yen)	86. 2 (yen)
Car Maintenance Cost (Car km)	1, 081, 515 101. 3 million km	10. 6 / km	14. 72	2. 9 (yen)	23. 1 (yen)	4. 9 (yen)
Transpotation Expense (Person・ton・km)	1, 575, 642 2, 965 million P. t. km	531. 41/10^3P. t. km	732. 50	146. 5 (yen)	596. 0 (yen)	510. 1 (yen)
Operation Cost (Car km)	3, 899, 192 101. 3 million km	38. 50 / km	53. 07	10. 6 (yen)	36. 5 (yen)	17. 6 (yen)
Total Material Cost (Car km)	8, 003, 894 101. 3 million km	79. 0 / km	108. 91	21. 8 (yen)	169. 6 (yen)	76. 2 (yen)

CHAPTER 13

APPENDIX

Ap. Table 13-1-1 Project Cost Summary

A. Project Cost ($us'000 in 1996 prices)

	Direct Cost	Indirect Cost	Physical Conti. Cost	Supervising. Cost	Detailed Desig Cost	Total Econ. Cost	Duty Tax (% on Econ. Cost.)	Financial
Stage 1	7,225	1,156	838	838	871	10,928	1,469 *13.44*	12,397
Stage 2	2,041	204	224	224	235	2,928	365 *12.47*	3,293
Stage 3	6,879	688	757	757	42	9,123	1,417 *15.53*	10,540
Total	16,145	2,048	1,819	1,819	1,148	22,979	3,251 *14.15*	26,230

B. Expenditure Plan (in $us'000 in prices 1996)

Year	Phase 1 (%)	E tot	Tax & D	Fin. Tot	AccCompl %
2002	55.6	6,076	817	6,893	
2003	27.1	2,961	398	3,360	56
2004	17.3	1,891	254	2,145	83
Total	(100)	10,928	1,469	12,397	100

Year	Phase 2 (%)	E tot	Tax & D	F tot	AccCompl %
2008	50.0	1,464	183	1,647	
2009	50.0	1,464	182	1,646	50
Total	100.0	2,928	365	3,293	100

Year	Phase 3 (%)	E tot	Tax & D	F tot	AccCompl %
2013	22.1	2,016	313	2,329	
2014	20.3	1,852	288	2,139	22
2015	19.8	1,806	281	2,087	48
2016	21.3	1,943	302	2,245	61
2017	5.5	502	79	581	71
2018	5.5	502	79	580	81
2019	5.5	502	78	580	90
Total	100	9,122	1,417	10,540	100

Notes: E means economic, F means financial and E.C. means economic cost
: DD means detailed designing and D means duty.

Ap Table 13-1-2 Urgent Recovery Cost

A. Recovery Cost by type and Class ($ in 1996 prices)

Type of Recovery	Class	Direct Cost a	Indirect Cost. b=a*0.1	Phys. Conti. Cost c=a*0.1	Total Economic Cost
Embankment Rehabilit	L	307,764	30,776	30,776	369,317
	M	102,588	10,259	10,259	123,106
	S	68,396	6,840	6,840	82,075
Stone fall Protection	L	18,058	1,806	1,806	21,670
	M	9,030	903	903	10,836
	S	4,514	451	451	5,417
Revetment Rehabilitati	L	1,609,266	160,927	160,927	1,931,119
	M	362,084	36,208	36,208	434,501
	S	181,042	18,104	18,104	217,250
Draineage Rehabilitatio	L	76,544	7,654	7,654	91,853
	M	51,030	5,103	5,103	61,236
	S	25,514	2,551	2,551	30,617
Bridge Rehabilitation.		51,216	5,122	5,122	61,459

Notes: $us 1.00 = Tug 550 = ¥ 110 in August 1996 prices.

B. Averaged Repair Cost per Damage in $us

Urgent 1) epair Work	Econ Cost in average	Econ Cost 1st stage	Econ Cost 2nd stage	Econ Cost 3rd stage
Class L 2)	1,256,800	1,738,272	434,501	1,082,858
Class M	123,100	123,100	123,100	123,100
Class S	82,080	82,080	82,080	82,080

Notes: 1) Class L (large) damage is represented by revetment rehabilitation work where the cost is the weighted average of 5 L and 4.1M resulting in $ 1256800
Class M is represented by embankment rehabilitation of $123100
Class S is represented by embankment rehabilitation at $82080.

2) It is found there is substantial cost differnce of the bank protection among stage1 through stage3 in Table 11-3-2 in Chapter 11, while the urgent repair cost which is converted to the economic saving at scale L is averaged at $1,256,800 for all stages. The cost is considered better to be revised to have differences among the stages, with which the benefit can have a magnitude matching with the staged project costing. The urgent repair cost of L in average at $1256800 is used in the master plan analysis. But for the analysis by stage, the unit cost shown under will be used.

Stage	Unit urgent repair cost		Occurence		Repair cost
1	*1,738,272*	*	3.8	=	6,605,434
2	*434,501*	*	1.4	=	608,301
3	*1,082,858*	*	3.9	=	4,223,146
total	1,256,800	*	9.1	=	11,436,881

Ap Table 13-1-3 Net Benefit Streams and EIRR

(In $us'mn of prices in 1996)

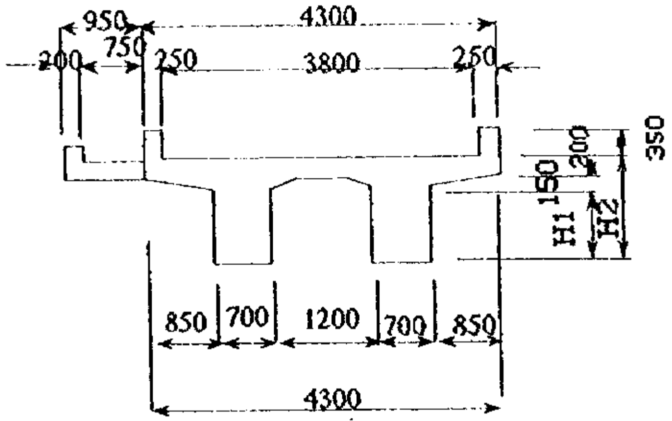
NO.	Yr.	Base case	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
0	2001	0						
1	2002	-6,076,000	-6,683,600	-7,291,200	-6,076,000	-6,076,000	-6,683,600	-7,291,200
2	2003	-2,344,941	-2,641,091	-2,937,241	-2,406,597	-2,468,253	-2,702,747	-3,060,553
3	2004	-976,727	-1,165,782	-1,354,838	-1,068,110	-1,159,492	-1,257,165	-1,537,603
4	2005	1,100,998	1,100,998	1,100,998	990,898	880,798	990,898	880,798
5	2006	1,113,902	1,113,902	1,113,902	1,002,512	891,122	1,002,512	891,122
6	2007	1,127,253	1,127,253	1,127,253	1,014,527	901,802	1,014,527	901,802
7	2008	-322,758	-469,140	-615,523	-436,864	-550,971	-583,247	-843,736
8	2009	-92,149	-238,531	-384,914	-229,317	-366,484	-375,699	-659,249
9	2010	1,602,780	1,602,780	1,602,780	1,442,502	1,282,224	1,442,502	1,282,224
10	2011	1,617,583	1,617,583	1,617,583	1,455,824	1,294,066	1,455,824	1,294,066
11	2012	1,632,778	1,632,778	1,632,778	1,469,501	1,306,223	1,469,501	1,306,223
12	2013	-367,689	-569,295	-770,902	-532,527	-697,364	-734,133	-1,100,578
13	2014	106,219	-78,967	-264,153	-89,589	-285,397	-274,775	-655,770
14	2015	656,918	476,293	295,668	410,601	164,284	229,976	-196,967
15	2016	710,518	516,210	321,901	445,158	179,797	250,849	-208,820
16	2017	2,302,717	2,252,543	2,202,370	2,022,271	1,741,826	1,972,098	1,641,479
17	2018	2,454,037	2,403,863	2,353,689	2,158,459	1,862,882	2,108,286	1,762,535
18	2019	2,592,496	2,542,323	2,492,149	2,283,073	1,973,650	2,232,899	1,873,303
19	2020	3,289,212	3,289,212	3,289,212	2,960,291	2,631,370	2,960,291	2,631,370
20	2021	3,289,212	3,289,212	3,289,212	2,960,291	2,631,370	2,960,291	2,631,370
21	2022	3,289,212	3,289,212	3,289,212	2,960,291	2,631,370	2,960,291	2,631,370
22	2023	3,289,212	3,289,212	3,289,212	2,960,291	2,631,370	2,960,291	2,631,370
23	2024	3,289,212	3,289,212	3,289,212	2,960,291	2,631,370	2,960,291	2,631,370
24	2025	3,430,770	3,430,770	3,430,770	3,087,693	2,744,616	3,087,693	2,744,616
25	2026	3,430,770	3,430,770	3,430,770	3,087,693	2,744,616	3,087,693	2,744,616
26	2027	3,430,770	3,430,770	3,430,770	3,087,693	2,744,616	3,087,693	2,744,616
27	2028	3,430,770	3,430,770	3,430,770	3,087,693	2,744,616	3,087,693	2,744,616
28	2029	3,430,770	3,430,770	3,430,770	3,087,693	2,744,616	3,087,693	2,744,616
29	2030	3,576,648	3,576,648	3,576,648	3,218,983	2,861,318	3,218,983	2,861,318
30	2031	3,628,909	3,628,909	3,628,909	3,266,018	2,903,127	3,266,018	2,903,127
31	2032	3,628,909	3,628,909	3,628,909	3,266,018	2,903,127	3,266,018	2,903,127
32	2033	3,628,909	3,628,909	3,628,909	3,266,018	2,903,127	3,266,018	2,903,127
33	2034	11,278,483	12,043,440	12,808,398	10,915,592	10,552,701	11,680,549	12,082,616
34	2035	2,063,170	2,063,170	2,063,170	1,856,853	1,650,536	1,856,853	1,650,536
35	2036	2,063,170	2,063,170	2,063,170	1,856,853	1,650,536	1,856,853	1,650,536
36	2037	2,063,170	2,063,170	2,063,170	1,856,853	1,650,536	1,856,853	1,650,536
37	2038	2,063,170	2,063,170	2,063,170	1,856,853	1,650,536	1,856,853	1,650,536
38	2039	4,112,523	4,317,459	4,522,394	3,906,206	3,699,889	4,111,142	4,109,760
39	2040	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
40	2041	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
41	2042	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
42	2043	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
43	2044	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
44	2045	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
45	2046	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
46	2047	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
47	2048	1,626,681	1,626,681	1,626,681	1,464,013	1,301,345	1,464,013	1,301,345
48	2049	8,012,417	8,650,991	9,289,564	7,849,749	7,687,081	8,488,323	8,964,228
49	Total	101197452	100508104	99818750	90388355	79579262	89699006	78200558
1%								
	EIRR	12.09%	11.09%	10.24%	10.99%	9.86%	10.07%	8.31%

Chapter 16

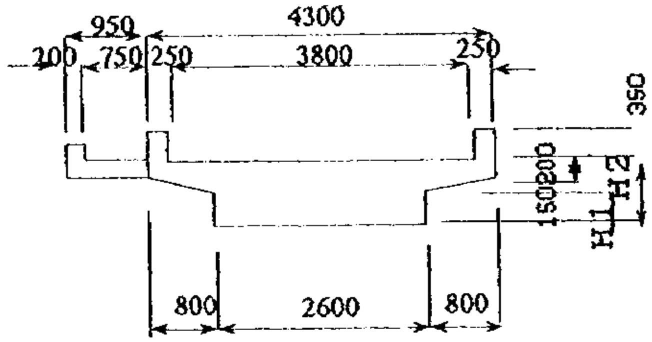
APPENDIX

Appendix 16-1

Typical section of the bridge at mid span and its dimensions are given as below;



T-Beam Bridge



Concrete Slab Bridge

Girder Length (m)	H1 (m)	H2 (m)	Width of Girder(m)	Bar arrangement	Remark
11.5	1.15	1.25	0.7	D32, 2 layers D29, 1 layer	T-Beam
9.5	0.8	0.95	0.6	D32 ,2 layers D29, 1 layer	T-Beam
7.3	0.3	0.65	2.5	D32, 1 layer	Slab

Appendix 16-1-1 Dynamics of Revetment

The most of destruction of riprap are occurred by the sink of natural embankment. The dynamic of revetment are proposed for the stability of revetment in consideration of design depth and flow velocity as shown in below;

1. Representative Basin : V_o

$V_o = \partial \times Vm$

here;

∂ : Compensate coefficient

Vm: Average velocity calculated by Manning's velocity formula

$Vm = 1/n \times Hd^{2/3} \times I_e^{1/2}$

here;

n : Manning's roughness coefficient (m/sec)

Hd : Design Depth (m)

I_e : Energy gradient (m)

Determination of Hd

following above mentioned condition, Hd is estimated base on site survey result and information at site as mentioned bellow;

Location	M.W.L (m)	H.W.L (m)
53 pk + 370	2.8	4.9
53 pk + 400	2.3	4.7
53 pk + 435	3.1	5.3
53 pk + 482	3.1	5.3

Note : M.W.L: Mean water level

H.W.L : High water level

5.3 m is apply for this calculation for Hd.

Determination of I_e

River bed slope of 1/400 is apply to I_e .which is based on cross section of survey carried out by MR.

Determination of 1/n

This river clarify SEGMENT 2-2, and material of river bed is a silt and grain diameter of 0.4 ~ 1 mm. The roughness coefficient of n = 0.022 is applied for such condition of soil material and river bed condition.

2. Diameter of Riprap : Dm

The diameter of Riprap is calculated following formula which was developed by the American military engineering ;

$$D_m = \frac{1}{E_1^2 x 2g\left[\frac{\rho_s}{\rho} - 1\right]} V_0^2$$

ρ_s : density of members
E_1 : experiment coefficient

In case of Vo= 7.0 (m/s)

Slope Gradient	Dm (m)
1 : 2	0.4
1 : 3	0.27

3. Determination of Thickness of Riprap

Tree time of Dm is preferable according to experience.
Slope gradient is deigned as 1 : 2, then 1.2 meter is proposed for this deign.

Appendix 16-2-1 Slope Characteristic of Location 13pk3

Slope length along the track ;	L=	200.0	m
Maximum height of the slope ;	H=	22.0	m
Approx. slope 1: n ;	n=	1.0	
Approx. area of the slope ;	A=	6,223	sq.m
Distance between track center and toe of the slope ;	l=	5.9	m

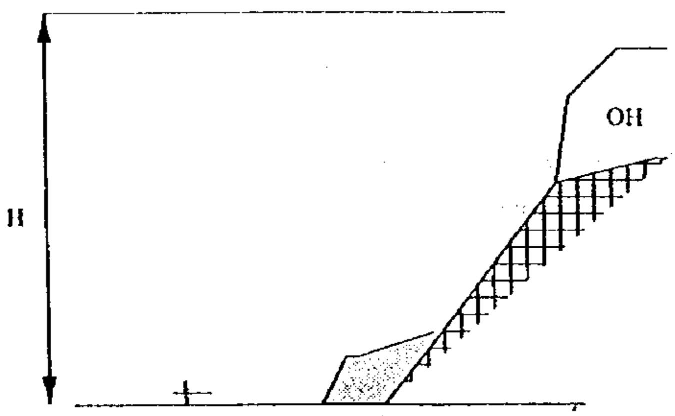
Item	Description
Weathering	22 m is the height of slope. Slope consists of 2 part, weathering rocks expose on upper part of surface and lower part covers by the talus cone. Some shrubs covers both side of slopes.
Unstable rock	Weathering unstable rocks locates on some part of upper slope.
Loose rock	Prominent loose rock in the right hand side on upper slope
Overhang	Lots of over hanged rocks locates boundary of upper and lower part.
Fallen rock	Talus cone locates at toe of slope, no destruction record of railway track.
Recommended Countermeasure	Removal of taulus cone, provision of rock pool, removal of overhang portion, foot strengthen, removal of weathering slope.

Schematic Section (Type I)

Weathered rock

Rock slope with well developed joints

OH Over hanging rock



Appendix 16-2-2 Slope Characteristic of Location 61pk10

Slope length along the track ;	L=	200.0	m
Maximum height of the slope ;	H=	17.6	m
Approx. slope 1:n ;	n=	0.8	
Approx. area of the slope ;	A=	4,723	sq.m
Distance between track center and toe of the slope ;	l=	4.6	m

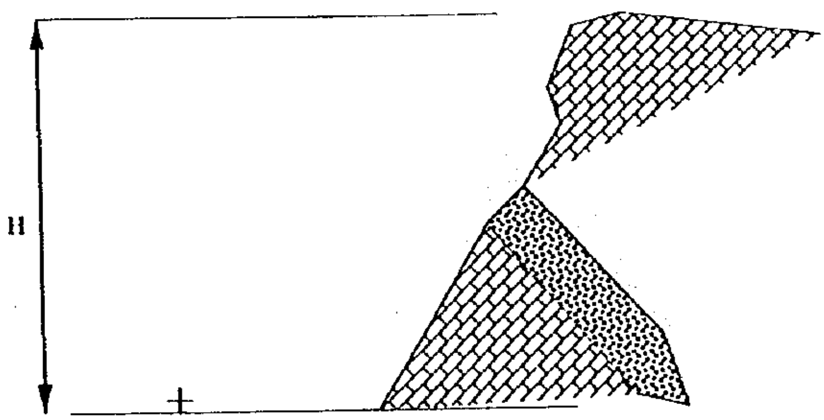
Item	Description
Weathering	Weathering remarkably proceed onto slope and consists of two stratums. Upper part makes cliff and lower part are piled by talus cones. About one meter boulders locates near side of railway line, such rocks fall down from upper part of exfoliation of hard rock and soft layer.
Unstable rock	Unstable rocks locates on upper slope should fall down because of weathering.
Loose rock	Lots of boulders locates on lower part of talus cone.
Over Hang	Over hang portion partially locates on upper part of cliff.
Fallen rock	Collapse rocks locates at toe of slope, no destruction record of railway track.
Recommended Countermeasure	Removal of talus cones, formative slope, provision of rock pool, foot strength, removal of weathering slope.

Weathered rock with developed joints

Deposits/Gravel

OH Over hang

Schematic Section (type II)

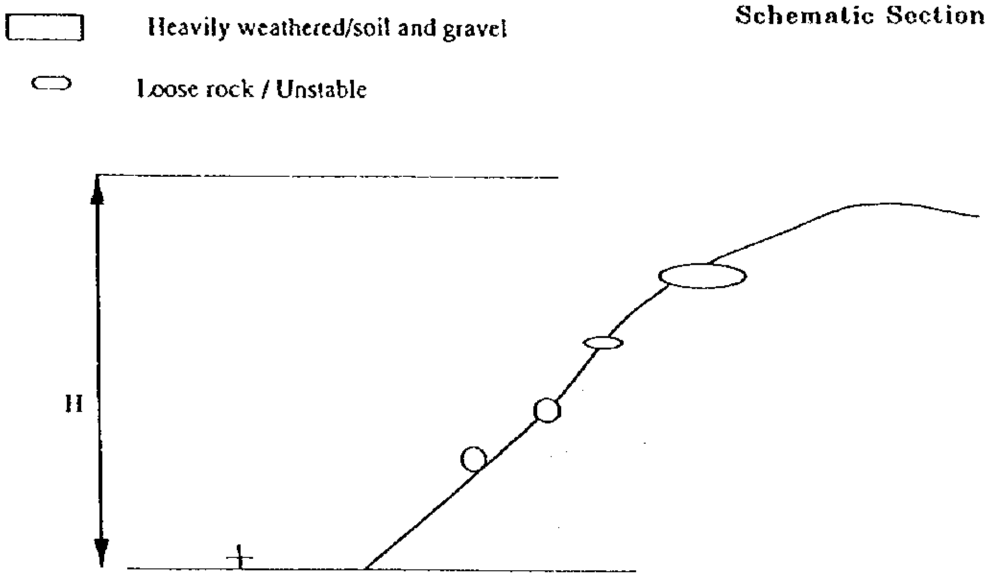


Appendix 16-2-3 Slope Characteristic of Location 282pk9-283pk2

Slope length along the track ;	L=	400	m
Maximum height of the slope ;	H=	24.3	m
Approx. slope 1:n ;	n=	0.8-1.0	
Approx. area of the slope ;	A=	13398	sq.m
Distance between track center and toe of the slope ;	l=	7.0	m

Item	Description
Weathering	Weathering remarkably proceed onto steep slope and consists of two part. Upper part makes steep slope and lower part makes slope by talus cone. One meter size boulders locates which comes from upper part's exfoliation of soft layer.
Unstable rock	Unstable rocks should fall down from upper part of slope because of weathering.
Loose rock	Lots of boulders locates on upper part of cliff.
Over Hang	Over hanged rocks partially locates on upper part.
Fallen rock	Boulders locates at toe of slope, no destruction record of railway track.
Recommended Countermeasure	Removal of talus cones, removal of over hang parts, foot strength, , removal of weathering slope and removal of loose boulders.

Schematic Section (III)

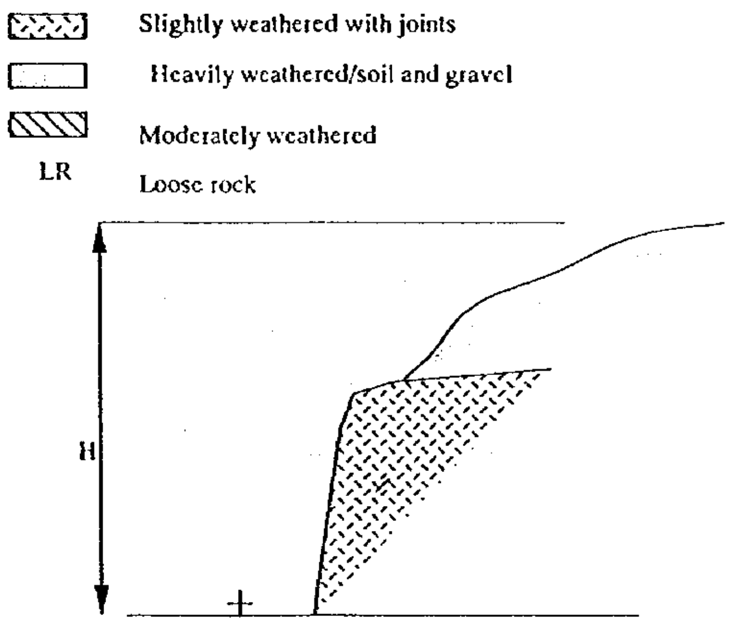


Appendix 16-2-4 Slope Characteristic of location 18pk10 - 19pk1

Slope length along the track ;	L=	150.0	m
Maximum height of the slope ;	H=	28.2	m
Approx. slope 1:n ;	n=	0.5 - 1.0	
Approx. area of the slope ;	A=	5,596	sq.m
Distance between track center and toe of the slope ;	l=	5.0	m

Item	Description
Weathering	Hard rocks expose onto slope surface. Some shrubs covers some part of slope
Unstable rock	Falling should occurrence, because hard rocks locates between soft layers
Loose rock	Loose boulders locates on the upper part of slope.
Over Hang	Over hang rocks partially locates upper part.
Fallen rock	Talus cones locates at toe of slope, no destruction record of railway track.
Recommended Countermeasure	Formative slope, provision of rock pool, concrete lining, removal of overhang portion, foot strength, removal of weathering slope, and removal of loose boulders.

Schematic Section (Type I)



Appendix 16-2-5 Slope Characteristic of location 267pk2-3

Slope length along the track ;	L=	150.0	m
Maximum height of the slope ;	H=	32.8	m
Approx. slope 1:n ;	n=	0.5 - 1.0	
Approx. area of the slope ;	A=	13,398	sq.m
Distance between track center and toe of the slope ;	l=	6.1	m

Item	Description
Weathering	Weathering remarkably proceed onto slope and consists of two stratums. Upper part formed by rock cliff and lower part covers by talus cones.
Unstable rock	Weathering rocks locates on upper part of slope, and seems to fall down.
Loose rock	Lots of boulders locates on lower part of talus cone.
Over Hang	Over hang rocks partially locates on upper part of rock cliff.
Fallen rock	Lots of boulders locates near the railway line, no destruction record of track structure.
Recommended Countermeasure	Removal of talus cones, provision on rock pool, removal of overhang, foot strength, removal of weathering slope and removal of loose boulders.

Schematic Section (Type IV)